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THE

MECHANICAL WORLD

AND

METAL TRADES JOURNAL

AN ILLUSTRATED PRACTICAL JOURNAL FOR ENGINEERS, MAKERS AND USERS OF MACHINERY, IRON FOUNDERS, DRAUGHTSMEN, ELECTRICIANS, ETC.

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INDEX TO CONTENTS.

JANUARY TO JUNE, 1893.

Articles marked *h* are illustrated. Articles marked *b* are Prize Competition Articles.

LEADERETTES.

ARTICLES.

SHIPBUILDING NOTES.

CATALOGUES, PRICE LISTS, ETC.

NOTICES OF NEW BOOKS.

TRADE NOTES.

METAL TRADE MEMORANDA.

METAL MARKET.

NEW COMPANIES.

OFFICIAL GAZETTE.

LETTERS TO THE EDITOR.

MISCELLANEOUS ITEMS.

QUERIES.

PATENTS.

REPLIES TO QUERIES.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

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NOTICE.—Index to Volume XII. will be issued with the next number. The price of next week's issue, with Index, will be 2d.

FRIDAY, JANUARY 6TH, 1893.

Starting of the Walsall Electric Cars.

THE Tramways Institute of Great Britain and Ireland, to whose proceedings reference has previously been made in these columns, met to again consider the subject of traction on tramways, in Birmingham, on the 30th ult., under the chairmanship of Mr. W. J. Carruthers Wain. At first, a discussion took place on a paper read at a previous meeting, dealing with the construction and maintenance of the permanent way of tramways; but the real object of the assembly was to receive a paper by Mr. A. Dickinson, descriptive of the electric tram lines of the South Staffordshire Tramways Company Limited. This company, it must be mentioned, have about 32½ miles of lines, and eight miles of this system, hitherto operated by steam cars, have now been converted into an electric system. The overhead trolley system has been introduced, and the plant and cars were set in operation on Saturday last, in the presence of the members of the Tramways Institute, and others. Space will not at present allow of a lengthy description of the installation, but the following salient features will be of interest. The lines connect together the localities known as Wednesbury, Walsall, Darlaston, and Bloxwich, and the generating station is located about the centre of these lines. It contains three Lancashire boilers, for a working pressure of 120lb., and three compound condensing engines, each of 125 I.H.P., which drive the dynamos by means of ropes. The dynamos are of the Elwell-Parker type and are three in number; they each give 250 ampères at a pressure of 350 volts, driven at a speed of 450 revolutions. A feeder cable is carried out from the generating station, and is laid underground 15in. below the street level, so as to feed the trolley wire near to the heaviest points on the line. The connections are made to the trolley wire every half-mile by means of branch distribution boxes. From each of these boxes are laid two cables which are carried up inside the pole and along the arm which supports the trolley wire, and are connected to the line breakers, which divide the trolley wire into half-mile sections. Special arrangements are provided at the turn-outs or points. The poles carrying the trolley wire are light, and are placed at the side of the footpath. The number of cars in use is sixteen, and each will accommodate 40 passengers—22 inside and 18 outside. Each car is fitted with two single-reduction motors of 15 brake horse-power, one being coupled to each axle by means of steel helical gearing wheels running in oil in a dust-proof case. There are two brakes to each car, a lightning arrester, and controlling, reversing and motor switches. The trolley or collector has to make an uninterrupted bridge through the constantly-varying space between the car and the trolley wire. This necessitates a vertical and a horizontal movement, and this Mr. Dickinson found could be obtained by combining a radial movement in a telescopic trolley stand with a hinge or bell-crank movement on the trolley mast itself. In fact, this arrangement forms what the trolley practically has—namely, a universal movement. The trolley mast is 13ft. long, and is made of very light taper steel tube, with the trolley fork at the small end and the bell crank at the larger end. The latter is pivoted in a jaw upon the trolley stand. The trolley wheel is kept up against the wire by means of six coiled springs pulling the short arm of the crank down towards a saddle upon the trolley stand, to which they are connected. The trolley itself is a small brass wheel, with flanges very similar to a rope pulley, and running in a wrought-steel frame with guards upon either side. The frame terminates at its base in a spindle which drops into a vertical bearing upon the end of the trolley mast. This gives the wheel and frame a free radial movement to adjust itself to the wire, apart from any horizontal movement of the trolley mast. In other words, the trolley stand forms the centre from which the trolley itself can in its movement upon the wire describe a circle of 26ft. in diameter. The rails form the return. It will be evident that this arrangement of the trolley is probably one of the most important features of the system, and as such is in advance of even American practice. Although only the second line—the first being at Leeds—on the overhead system of collection in this country, it will doubtless tend to further progress in this direction.

A New Submarine Boat.

A TRIAL has just taken place at Civita Vecchia, Italy, of a new submarine boat, invented by Degli Abati, and which is operated by electricity. Considerable interest had been manifested in the experiment, and in addition to a distinguished assembly, the Italian Government sent two naval officers to witness the test. The boat, which is called "L'Audace," was built at Savona, according to the designs of the inventor. She is 28ft. long, 8ft. wide, and is said to have the peculiar depth of about 11ft., the total weight being 40 tons. The special advantages claimed for this boat over all others are the length of time it can remain under water (48 hours) and the depth to which it can descend (130ft.). These claims were, however, not borne out at the trial, which was brought to a speedy termination by an accident. The boat was towed out of the harbour to a spot where the water was 130ft. in depth, and no less that 20 minutes were occupied in causing the boat to sink immediately below the surface of the sea. The boat then sank rapidly, as was shown by the paying-out cable connecting the submarine boat with the launch, to a depth of 50ft., when the signal for an immediate ascent was received by the launch, and 20 minutes after the boat disappeared she was brought up to the surface. The rapid descent was due to some inexplicable cause, whilst the son of the inventor had one of his hands crushed in the gearing. It was, of course, not intended that the boat should sink quickly, and in further experiments the inventor is sanguine that such a *contretemps* will not recur. It is a case of *l'audace, toujours l'audace.*

English Coal for the German Navy.

CONSIDERABLE astonishment has been caused in Westphalian coal circles by a statement made by a Cologne paper that the Imperial Naval authorities have, through the agency of intermediaries, just placed contracts in England for the supply to the German Navy of all the coal it will require for the fleets during the next two years. The information, it is added, has been obtained from a good source, and the contracts were, it is said, entered into notwithstanding the fact that the Westphalian coal owners quoted exceedingly low prices, whilst further contracts have been made with colliery proprietors in the Ruhr district for the delivery of coal in the event of war. Though the information has been derived from what is termed a reliable source, official confirmation of the assertion is asked for, and it seems probable that more will be heard of the matter.

The Projected Electric Railways in Berlin.

THE projects for the construction of electric railways in Berlin, on the lines of the City and South London Electric Railway in London, and the Elevated Railroad in New York, do not appear to assume any definite shape; and, for that matter, two considerations which the Town Council of Berlin have laid stress upon in the different negotiations with those interested have been the practicability and possibility of raising the necessary capital. Confirmation of this statement is to be found in a report of the "Municipal Architects' Deputation" for the year ending last April, and only now issued. It appears that after investigating the working of the electric railway at Buda-Pesth, a deputation on behalf of the Berlin municipality approached the Greater Berlin Tramway Company with a view to the latter laying down an experimental line on the open-conduit system so ably carried out at Buda-Pesth by Messrs. Siemens and Halske. This proposal was, however, not definitely adopted, since the tramway company was about to conduct experiments with secondary-battery cars; but, for all that, hese cars have not yet appeared. About that time Messrs. Siemens and Halske brought forward schemes for tion of elevated electric railways, and the General Electricity Company (Allgemeine Elektricitats Gesellschaft) for underground lines. It was then suggested to the former that they should establish an experimental line, so as to demonstrate the practicability of the system they proposed to employ. That was the position in April last, and that is how the matter stands to-day at the beginning of 1893. The railways projected by that firm alone were: (1) From the East to the West; (2) from Friedrichstrasse to Grunewald; and (3) Friedrichstrasse to Gesundbrunnen-Pankow. So far, German financiers have not given to this class of electrical engineering the same support which they have to other electrical undertakings. They are doubtless awaiting developments in England and the United States.

Bogus Electrical Appliances.

WE have hitherto refrained from making any remarks concerning bogus electrical appliances, but the time has now arrived for a few observations. As our readers are doubtless aware, there are issued in various quarters what are termed "electropathic belts," "electric corsets," etc.; but probably the most delusive is an appliance which it is claimed will restore the sight of the blind, cause the dumb to speak, etc., all for a few shillings. Well may one ask, What next? As a matter of fact, the so-called electropathic belts and similar goods are really not electrical. They can only give an infinitesimal current, which does not reach the body; and even if it did, it is so exceedingly slight as to be of no utility, and cannot possibly have any beneficial or other effect on a person. It is in this, then, that the public is deluded; and the fact has been conclusively proved by experts on many occasions. We are, therefore, surprised to find a publication called "Invention," which professes to be a "weekly review of industrial and scientific progress," puffing such articles. On December 24 "Invention" stated that "a remarkably cheap and efficient electropathic belt has been brought to our notice. . . . It appears to be well constructed, light, warm, and comfortable." The belts are of "the strongest electric power"—whatever that may mean. In its issue for December 31 we find: "The enormous increase in bogus electrical appliances in England seems to have considerably affected the English electricians, . . . as they are powerless to prevent the public from being victimised," etc. This is blowing hot and cold with the same breath with a vengeance. "Invention" should know better than to lend itself to such inconsistency, and especially in two consecutive numbers. We are afraid that the electrical knowledge of the editor must be something like the power of the belt—infinitesimal; whilst his memory is, to say the least of it, short. We are, however, pleased to say that the electrical and other respectable journals have for a long time shown up the fallacies of bogus appliances; and, moreover, we are given to understand the the "Times," and one or two other metropolitan daily newspapers, have now refused to again insert advertisements referring to these articles.

The Chicago Tower.

IT appears that after the many designs which have been suggested for the World's Fair tower, it has been definitely decided to build one of steel, 560ft. in height and 210ft. in diameter. The tower is to be cylindrical in outline, and in design has certainly no claims to elegance. An inclined railway will extend from the bottom to the top of the tower on the outside, which will be of truss construction, and will add to the strength of the structure, bracing it against wind storms. The railway is placed on the outside of the tower to enable passengers to have a clear view of the surroundings. The gradient is a little less than 8 per cent., the track is a mile in length from bottom to top, nine complete turns being taken in the ascent. An observatory is located at the top. The quantity of material to be used is from 3000 to 3500 tons of structural iron and steel, 200 tons of ornamental iron and 500,000ft. of timber. The railway cars will be electrically propelled and each will hold ten passengers. Ninety trains are expected to be in continuous operation, half of them ascending and half descending. It is estimated that 10,000 lights, principally incandescent, will be required to properly illuminate the tower. A Siemens-Halske search-light of great power will be placed on the top. It is the intention of the company to make the tower a permanent institution and not merely a feature of the fair.

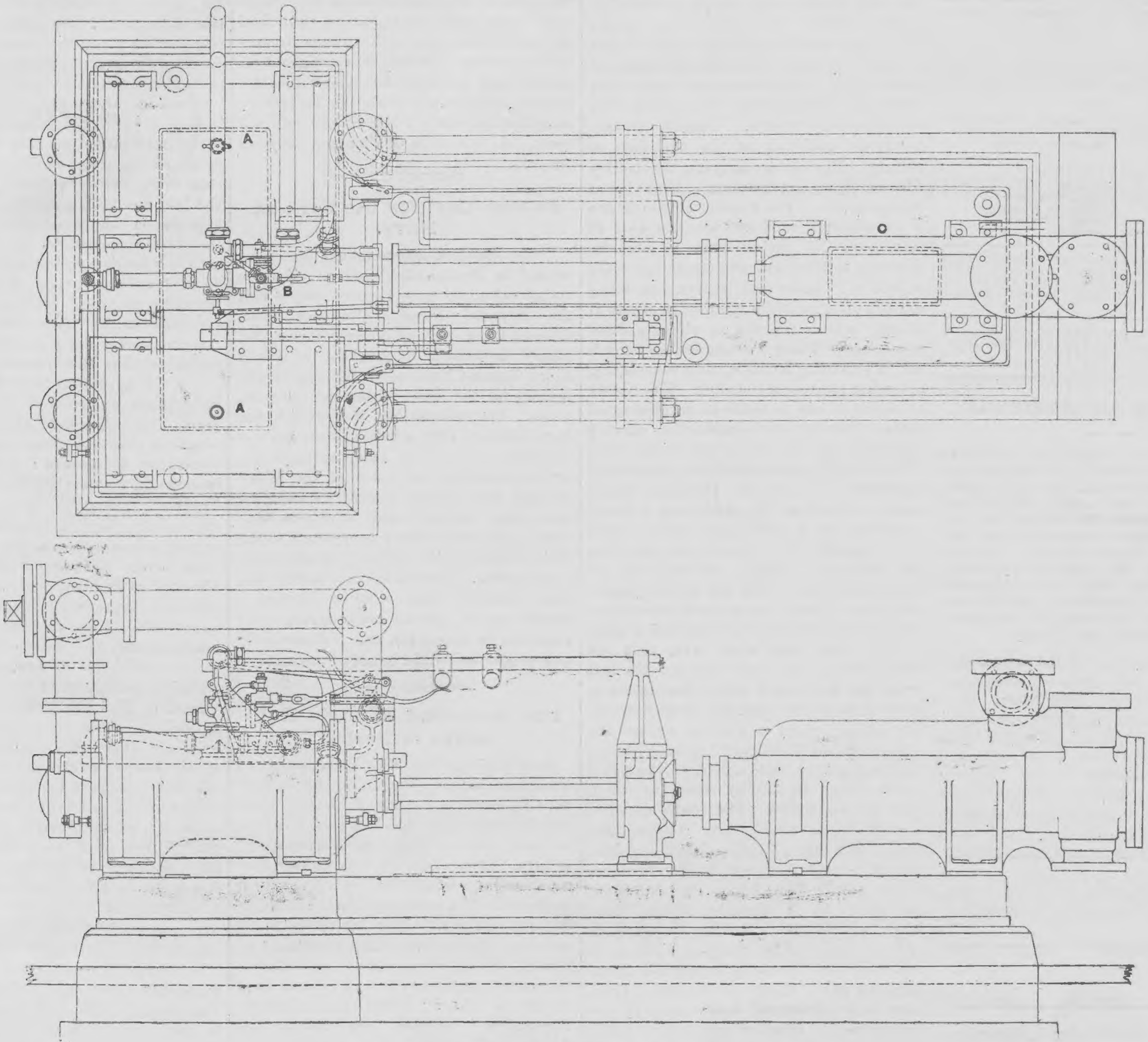
THE first practical application of electricity for heating hot-water pipes was made recently by Mr. R. McCormack, of Ottawa, with an installation of Ahearn heaters. Five separate heaters are used to heat about 300ft. of pipe.

Hydraulic Machinery.—XII.

Reciprocating motions are easily obtainable from hydraulic power, and are much used for hydraulic pumps for various purposes.

Fig. 36 shows a combination creosote and air pump worked by a hydraulic cylinder, as made by Messrs. John Abbot and Co. Limited, of Gateshead, for the King's Lynn Dock Company, which has worked very satisfactorily. The two outside cylinders A are for air. The centre cylinder B is the hydraulic working cylinder, and C is the creosote pump. The whole is self-contained on a strong cast-iron bedplate, and is securely bolted to the masonry. The reversing is accomplished by means of tappets actuating a small slide valve, which admits pressure to a small cylinder actuating the main slide valve. To reduce the concussion and prevent the knock at each end of the stroke so often found in this class of pump, the ports are made V-shaped to cut off the water gradually, and small throttle valves are also inserted in the pressure and exhaust pipes. The pressure in the working cylinder is 700lb. per sq. in., and the creosote cylinder can be forced up to 150lb. on the sq. in. The pump works up to 18 double strokes per minute = about 80ft. per minute. The water pressure is obtained from the mains running round the dock, and obviates all danger of fire. The same firm have also used this class of pump for brine pumps, wells, fire pumps, and for intensifying the pressure for the final squeeze in hydraulic presses.

(*To be continued.*)



Hydraulic Machinery.—Fig. 36.

Sir Edward Watkin, presiding in London, on the 29th ult., at a meeting of the Channel Tunnel Company, said a bill for power to resume operations would be introduced next session. Regarding the discovery of coal in the course of boring operations, a separate coal company would be formed, and he had taken £1000 in shares. The engineer's report, which the meeting adopted, stated that the condition of the trial borings remained good, and nine valuable seams of good bituminous coal suitable for household purposes had been found.

Mechanical and Engineering Drawing.—I.

By a Practical Draughtsman.

Introduction.—In writing a series of articles on this subject, we may at the outset remark that the inducement to undertake such a task is the desire to place within the reach of the many earnest students and apprentices in engineering factories and shops throughout the kingdom a means of acquiring the ability, not only to *read*, but to *make* such drawings as are placed before them in the shops to work from, and in some measure to prepare them before they enter the drawing office for the further study of machine and engine design.

It is assumed by the majority of students and apprentices to mechanical engineering that the drawing practised in the drawing office will be taught them upon their admission within its doors; but an experience of many years in some of the principal drawing offices in England has made the writer alive to the fact that absolutely nothing is taught to the engineer or draughtsman in embryo, but that if he ever acquires a knowledge of the principles involved in the practice of the engineering draughtsman, it will only be by the earnest study of those principles before he enters the drawing office.

Our science schools have helped but little in doing that for the student or apprentice which should be done for him before he enters a drawing office; and until a better system of imparting a knowledge of the kind of drawing actually required in such an office is provided in those schools, we fear that little will be accomplished towards even helping to make efficient engineering draughtsmen. Whether the plan adopted in imparting a knowledge of engineering drawing as unfolded in this series of articles is an improvement on any that has gone before, must be left to those who earnestly follow the exposition of it to decide.

The Necessity of Acquiring the Ability to Draw.—Before proceeding with the exposition of that plan we would, however, put before the student some facts bearing upon the study of drawing, and mechanical drawing more particularly, which may help him to appreciate the absolute necessity that exists for his acquiring the ability to draw, if he has any desire to rise in his profession. Without wishing in the least degree to under-estimate the great worth of a really first-class skilled workman who may have little or no knowledge of drawing, it is still a fact admitted on all hands that just in proportion to the knowledge of drawing possessed by one workman over his fellow, so is he superior to him; and as a consequence it follows that those ignorant of that art must hold a lower position in the scale of ability as workmen than those who have attained to a knowledge of it.

The utility of the power to draw may not present itself to the mind of the workman on its first suggestion to him, but a little thought about the matter will soon make it clear that it has a much closer connection with his daily work than he had any idea of. Neither spoken nor written language can at all times convey ideas that we wish to impart to another, and recourse must be had to some other means, more especially if those ideas relate to the form and position of material substances. To assist us in making our meaning clear we must make use of what has been aptly called the "language of mechanics," or drawing—a language which appeals at once to the eye for the truth of its assertions, and which enables us without further assistance to judge of the form, appearance, and dimensions of bodies.

To the intelligent mechanic a real power of drawing is a priceless advantage, as it enables him to either reproduce a true representation of forms that upon a casual inspection may have made an impression on his mind; or, on the other hand, to transfer to paper what he may have conceived, but which has not as yet had any existence. Many a valuable invention has been lost to posterity solely through the inability of the would-be inventor to make that transcript of his mind through the aid of drawing which might have made him a benefactor to his race.

Again, the times we live in demand a knowledge of the graphic art by all who are in any way connected with mechanical constructions of any kind, whether it be engines, machinery, steamships, guns, or a host of other things; and no one can nowadays hope to obtain any position of trust or emolument in any service, public or private, that an engineer fills, who has not acquired the power of correct drawing. It was long a fallacy with many that draughtsmen were *born*, not made, that although a youth—or, for that matter, a man—could be taught to copy letters and eventually to become a good scribe, yet the law did not hold good as regarded drawing. Happily, that fallacy has gone the way of many others, and it is now held that those who will give the requisite concentration, coupled with persistent effort, will undoubtedly attain deserved success.

(*To be continued.*)

An Engineer's Notes.

TABLE OF SAFE LOADS ON SMALL WROUGHT-IRON STRUTS.

Cross Section of Angles or Tees (inches).	Length in Feet.					
	3	4	6	8	10	12
	Load in Tons.					
2 × 2 × ¼	2·18	2·00	1·40	1·05	0·94	0·60
2 × 2 × ⅜	3·00	2·61	2·35	1·43	1·08	0·82
2½ × 2½ × ¼	2·71	2·43	1·93	1·43	1·14	0·85
2½ × 2½ × ⅜	4·00	3·55	2·81	2·10	1·66	1·24
3 × 3 × ¼	3·50	3·26	2·77	2·25	1·86	1·50
3 × 3 × ⅜	5·10	4·83	4·09	3·33	2·78	2·22
3 × 3 × ½	6·70	6·28	5·31	4·38	3·61	2·90
3½ × 3½ × ¼	4·21	4·00	3·33	2·66	2·21	1·76
3½ × 3½ × ⅜	6·15	5·85	5·03	4·22	3·56	2·90
3½ × 3½ × ½	8·10	7·54	6·74	5·80	4·90	4·04
4 × 4 × ⅜	7·24	7·00	6·32	5·52	4·31	4·10
4 × 4 × ½	9·28	9·00	8·06	7·[illegible]2	6·26	5·35
4 × 4 × ⅝	11·7	11·2	10·6	8·90	7·75	6·43

Note.—The factor of safety taken is 6, and the ends are understood to be fixed.

Machine Construction.

THE CONSTRUCTION OF MACHINE ELEMENTS.

(*Continued from page 253, vol. xii.*)

§ 149.

COMBINED SECTIONS. WOODEN SHAFTING.

THE dimensions for shafting of various combined sections (tubular, cruciform, and fluted) are determined by finding the size for round shafting of the same material, and then deducing the dimensions of the desired section in the same manner as given for axles in §§ 138 to 142.

Axles of wood (generally oak) are made of polygonal section described about a circle not less than 1·75 times the diameter

force whose reactions are parallel to Q, and are $P_1 = \frac{Q\,s}{a+s}$ at A, and $P_2 = \frac{Q\,a}{a+s}$ at B. The greatest stress is at C, for there both bending moments are at their maximum $M_b = \frac{P_1}{a} = \frac{P_2}{s}$, hence calculation should be made from this point.

Example.—Let Q = 5500lb., R = 11¾in., a = 19¾in., s = 78¾in., then

$$P_1 = \frac{78{\cdot}75}{98{\cdot}50}\,Q = 0{\cdot}8\,Q = 4400\text{lb.}$$

$$P_2 = \frac{19{\cdot}75}{98{\cdot}50}\,Q = 0{\cdot}2\,Q = 1100\text{lb.}$$

Also $M_d = 5500 \times 11{\cdot}75 = 64{,}625.$
$M_b = 4400 \times 19{\cdot}75 = 86{,}900.$

Hence $M_b > M_d$ and formula (140) is used.

We have $(M_b)_i = 0{\cdot}975 \times 86{,}900 + 0{\cdot}25 \times 64{,}625 = 84{,}727 + 13{,}656 = 98{,}383$in.-lb.

FIG. 421.

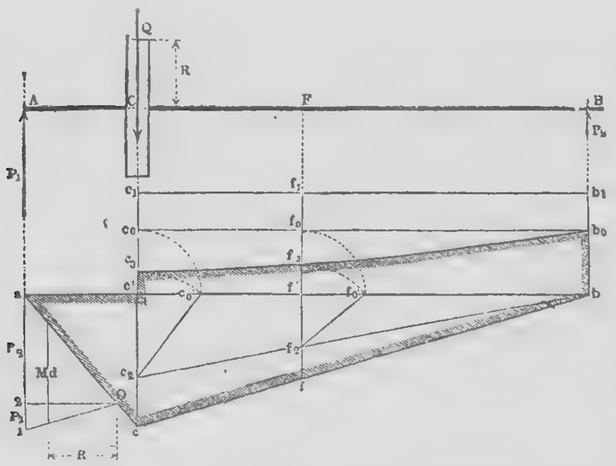


FIG. 422.

of a cast-iron shaft for the same work, this being the fourth root of the ratio of the moduli of elasticity of the two materials. Wooden shafting is now seldom used.

§ 150.

SHAFTING SUBJECTED TO DEFLECTION.

Shafting is often loaded in such a manner as to be subjected to bending stresses, and, as already seen, this is the most general condition in which it is used. Under these circumstances the combined resistance must be taken into consideration. This is most conveniently done by assuming an ideal bending moment (see § 18).

From this the diameter at C can be calculated. If the shaft is of cast iron with cruciform section, we have for the diameter D,

$$(M_b)_i = S\,\frac{\pi}{32}\,D^3$$

and taking S = 4250, we have

$$D = \sqrt[3]{\frac{98{,}383 \times 32}{4250\;\pi}} = 6\tfrac{1}{4}\text{in.}$$

The journal at A is found in the table of § 91, column 4, to be about 2¾in. For the neck journal at B we have from the table of § 45, taking the double value for cast iron, $d_2 = 4\tfrac{1}{2}$in.

Graphical Method.—The same example may be solved graphically. In Fig. 422, with a horizontal closing line, construct

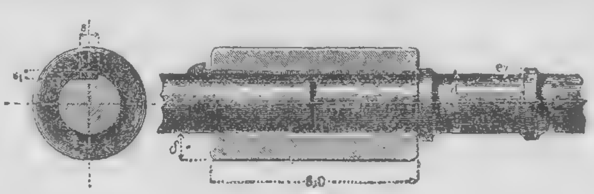


FIG 423.

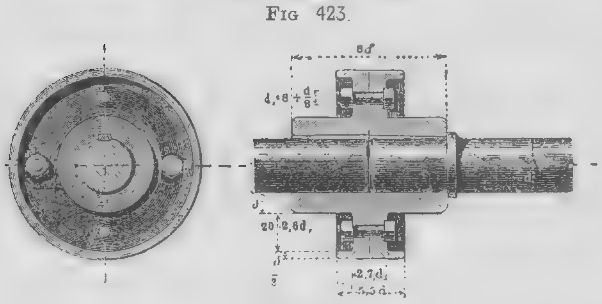


FIG. 424

Let M_d be the twisting moment for a given shaft section, M_b the bending moment for the same section, then the ideal bending moment combining them both will be :—

$$(M_b)_i = \tfrac{3}{8}\,M_b + \tfrac{5}{8}\sqrt{M_b^2 + M_d^2} \;\ldots\ldots(139)$$

This formula may be simplified for numerical calculations by Poncelet's theorem, approximately :—

When $M_b > M_d$ take $(M_b)_i = 0{\cdot}975\,M_b + 0{\cdot}25\,M_d$……………(140)

And when $M_d > M_b$ take $(M_b)_i = 0{\cdot}625\,M_b + 0{\cdot}6\,M_d$……………(141)

An examination will be made, first by the analytical, and then by the graphical method.

1. *Analytical Method.*—The axle or shaft A B C, shown in Fig. 421, carries a gear wheel R at C, which acts tangentially to rotate the shaft with a moment M_d = Q R, and also acts to bend the shaft with a

the link polygon $a\ b\ c$, for the bending moments, and the force polygon a 10, giving the forces P_1 and P_2, and also $a\,c\,c'$, the surface of moments for the shank A C.

The moment M_d is yet to be determined. In the force polygon with a distance R from the pole O draw a vertical ordinate; this will be M_d. Lay its value off at $c'\,c_1$, and $b\,b_1$, and $\frac{5}{8}$ of these values give $c\ c_0\ b_0\ b$ for the parallelogram of torsion for the shank C B.

The combination of the bending and twisting moments may then be made by formula (139). Make $c\,c_2 = \frac{3}{8}\,c\,c'$ and join $c\,b$, then at any point of the polygon—as, for example, at f—the distance $f\,f_2 = \frac{3}{8}\,f\,f'$. Now transfer $c'\,c_0$ to $a\,b$, at $c'\,c_0'$; then will the hypotenuse of the triangle $c_2\ c'\ c_0'$ divided by $c_2\,c_0' = \sqrt{(\frac{3}{8}\,c\,c')^2 + (\frac{5}{8}\,c_1\,c')^2}$, and the sum $c\,c_2 + c_2\,c_0' = c\,c_2 + c_2\,c_3$ the desired moment $(M_b)_i$ for the point C. In the same manner we obtain $f\,f_2 + f_2 f_0' = f\,f_2 + f_2\,f_3$, the moment $(M_b)_i$ for the point F. The line $c_3\,f_3\,b_0$ is a curve (hyperbola) which may be taken approximately with sufficient accuracy as a straight line $c_3\ b_{02}$. The various dimensions may be obtained from the polygon $a\ c\ b\ b_0\ c_3\ c'$ in a similar manner as shown in the discussion of angles.

Other discussions of this subject will be given when considering rock shafts and crank axles.

CHAPTER X.

COUPLINGS.

§ 151.

VARIOUS KINDS OF COUPLINGS.

The devices by means of which the different lengths of shafting are connected together so that the motion may be transmitted from one piece to the next, are called couplings.

They may be classed as follows :—

1. Rigid couplings.
2. Flexible couplings.
3. Releasing, or clutch couplings.

The first class includes the various forms of coupling for line shafting and the like, in which the coupling and the coupled portions have the same geometric axis. Flexible couplings are those which permit more or less change in the relative position of the coupled shafts; while clutch couplings are constructed so as to be thrown in and out of engagement, usually when the parts are in motion. These three classes

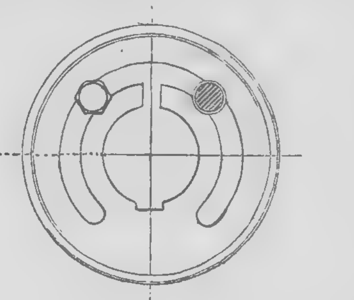


FIG. 429.

are all shown in various forms in the following examples :—

§ 152.

1. *Rigid Couplings.*

Rigid couplings may be made either in a single piece, or in several parts. Of the first sort is the so-called muff couplings (Fig. 423). The muff is fitted over both pieces of shafting, and a single key binds the parts all firmly together.

In giving the proportions of the various parts of the following couplings, we may take for a unit or modulus the thickness δ of the hub, making its value equal to :—

$$\delta = \frac{d}{3} + \frac{3\text{in.}}{16} \;\ldots\ldots\ldots\;(142)$$

d being the diameter of the shaft, whether of wrought or cast iron. The dimensions

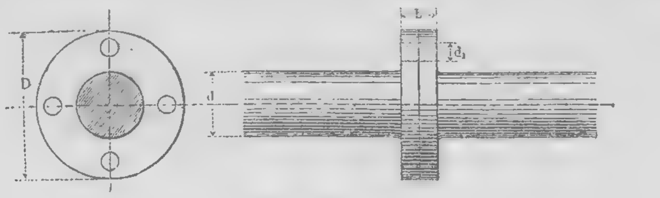


FIG. 425.

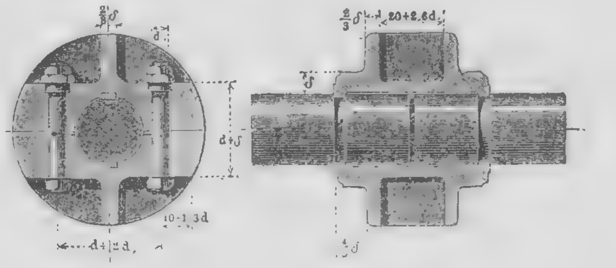


FIG. 426

of the key may be taken as given in § 68, formula (71), for torsion keys.

More recently, in exposed situations, the projecting end of the key is covered with a cap, in order to avoid accidents.

The form of couplings shown in Figs. 189 and 190, § 69, looks very practical, but the test of prolonged use will be necessary to demonstrate its merits.

The simplest two-part coupling is the well-known plate coupling, Fig. 424, and its form permits the nuts and bolt heads to be kept below the projecting flanges, and thus out of the way.

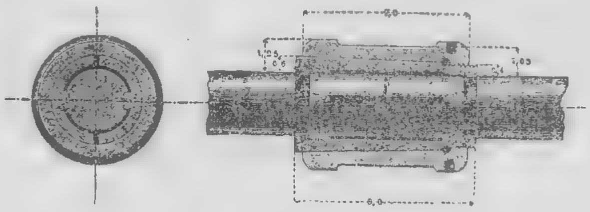


FIG. 427.

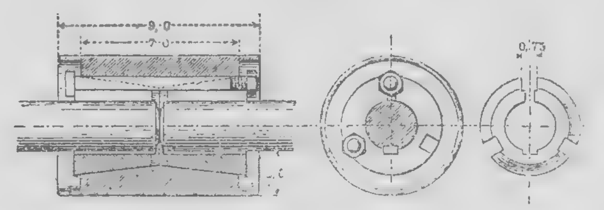


FIG. 428.

The number of bolts in a plate coupling $i = 0{\cdot}8d + 2$. The diameter d of the bolts should be $0{\cdot}125\,d + \frac{5}{16}$in., which gives a strength proportional to that of a shaft calculated by formula (133), or if d is determined from formula (133) the bolt will be strong enough.*

Plate couplings are extensively used in England and Germany, although they are being superseded by later forms. Their strength has caused them to be used for coupling the lengths of screw propeller shafts, and in this case the plates are forged on the shafts, thus dispensing with the use of a key, Fig. 425. This form was introduced by Langdon in 1852, and is in general use, 4 to 6 bolts being used.

Examples.—The following cases will serve to give the proportion of such plate couplings in executed designs :—

"Jason," James Watt and Co., d = 12in., D = 24in., d_1 = 3in., b = 6in., i = 4.

"Warrior," John Penn and Son, d = 17in., D = 37in., d_1 = 4in., b = 10, i = 6.

Vessel by Ravenhill and Hodgson, d = 12in., D = 25, d_1 = 3in., b = 6in., i = 4.

Fig. 426 shows a clamp coupling divided into two parts longitudinally. This form is provided with two keys, assisted by the manner in which it is bolted together. If it is desired to clamp the shafts together endwise, the small circumferential grooves and lips may be used as shown. Such grooves may be used in depth equal to $0{\cdot}01\,d + \frac{1}{16}$in., but may be omitted where endlong clamping is unnecessary. If lock nuts are used on the bolts the main nuts may be countersunk, as shown in the illustration. The number of bolts is = 2, 4 or 6—rarely more—and of diameter as follows :—

* The dimensions in Fig. 424 are correct for English measurements, except the bolt diameter, which is as given above, and the distance from hub to inside of flange, which should be $2{\cdot}6\,d + 1\tfrac{3}{8}$in.

$$i = 2, \quad 4, \quad 6 \text{ or more.}$$
$$d_1 = \frac{d}{6} + \frac{3\text{in.}}{8}, \quad \frac{d}{7} + \frac{11\text{in.}}{32}, \quad \frac{d}{8} + \frac{5\text{in.}}{16}.$$

Example.—For a shaft 2⅜in. diameter, with a coupling fitted with two bolts, the diameter d_1 = 0·77in., say 13/16in., for four bolts d_1 = 0·72in., say ¾in, for six bolts d_1 = 0·67, say 11/16in.

This form of coupling has been made with bolts with differential thread passing through both parts and giving increased clamping force.*

The cone coupling shown in Fig. 427 is the design of the author, and is a modification of the preceding form. The keys are cast in one with the halves of the inner cone, and are planed to fit the keyways in the shafts. The cone is made with a taper of 1/40 on a side, which will hold the parts securely when driven on without any other fastening. If there is much vibration, however, it is advisable to have a screw thread cut on the inner cones as shown, and the outer shell tightened by a spanner. In most ordinary cases the screw may be omitted, and a small steel countersunk set screw tapped into either side of the shell to clamp the inner cone. If endless motion need not be considered the circumferential grooves may be omitted.

With couplings for shafts larger than 2½in., the bearing surfaces should be recessed to reduce the amount of finishing.

In America, Sellers has introduced a clamp coupling in which two cones are opposed to each other and drawn together by three bolts, the whole being enclosed in a cylindrical shell, bored out to fit the cones as shown in Fig. 428. The cones are cut through on one side so that they are compressed by the action of the bolts. A key is let into the cones and shafts diametrically opposite the cut in the cones. An especial advantage which results from the double cone construction lies in the fact that it is not necessary for the two shafts to be exactly the same diameter.†

In England, Butler's cone coupling has been used, and was designed for use with the cold-rolled shafting described in § 148. It is similar in construction to Sellers', the three bolts being replaced by a single concentric screw thread and nut at each end. The key which Sellers uses is omitted in Butler's coupling, the shafts being held only by the clamping action of the cones.

In the United States, Cresson's coupling is also much used. Its construction is shown in Fig. 429. The clamping surfaces are cast in one with the outer shell, and forced upon the shafts by means of the tapering screws. This coupling possesses the same advantage as does Sellers', in being adapted to shafts of slightly unequal diameters.

(To be continued.)

Leeds Association of Engineers.

At the last ordinary meeting of this association, the president, Mr. Robert Lupton, in the chair, Mr. Francis Rixson, of Sheffield, read a paper on the "Selection and Treatment of Steel for Forgings." Speaking of the several methods of making mild and other steels for mechanical and kindred purposes (not alluding to the crucible process, which had already been discussed), he said that for high-class work engineers and technical experts generally agree that the Siemens process is the one most reliable, its earlier sister-process, the Bessemer—for which the world owes much not only to Sir Henry Bessemer, but also to Mushet, whose spiegeleisen made the blown or decarbonised metal malleable, also to Heath and other workers, whose names do not often appear in the light they deserve,—being superior where quantity is the first consideration, without admitting of such nice gradations of temper and quality. There was also the more recently developed basic process, yielding a class of material for constructive and commoner purposes. Mr. Rixson said he preferred a stiff steel of good quality to a soft steel of low character, and always questioned the judgment of engineers who stipulate that their forgings shall be made of steel under 0·15 carbon, his opinion being that about 0·30 was better in every way. The paper was illustrated by numerous specimens of steel work, tested in various ways, and was throughout most interesting and instructive. A discussion followed, in which Messrs. Lupton, Drake, Atkinson, Moorhouse, Holgate, Wood, Towler, and Blackburn took part; and a vote of thanks to Mr. Rixson, proposed by Mr. Tempest and seconded by Mr. Blackburn, was carried unanimously.

* Ruggles' Coupling, "Pract. Mech. Jour.," 1866, p. 185. In Fig. 426 there are two dimensions which require transforming: For 20+2·6d, use ¾in.+2·6d, and for 10+1·3d use ⅜in.+1·3d.

† Among other tests the Sellers coupling stood the following:—Two shafts 10ft. long were fitted in three hangers, the middle hanger next the coupling being set 1¾in. out of line, and after several weeks' time, at 250 revolutions per minute, the coupling remained intact.

The New Decimal Association.

When, in the month of June, 1891, a combined deputation from the New Decimal Association and the Associated Chambers of Commerce waited upon Mr. Goschen, he, in reply to their request that a Select Committee should be appointed to inquire into the need of reform, said that he would not oppose the appointment of such a Committee, but that before any decided move on the part of the Government could be made, the popular voice must be heard expressing a desire for the proposed change. Since that date the New Decimal Association has been actively engaged in distributing information on the subject and in securing extended support. The present Chancellor of the Exchequer and President of the Board of Trade have been in turn asked to hear the views of the leaders of this movement, and have promised to receive a deputation on the 25th inst.

When it is mentioned that it is expected that the Duke of Westminster and other peers, the Agents-General for Victoria, the Cape of Good Hope, and Queensland, several members of Parliament, and delegates from the principal Chambers of Commerce and from the Trades Councils of Manchester, Sheffield, Glasgow, etc., have promised to take part in the proposed demonstration, it will be recognised that there is some reasonable evidence put forward that the subject is obtaining sufficient interest to warrant the demand of the New Decimal Association for the appointment of a Select Committee to inquire into the whole question.

This subject has lately received much attention in the United States of America and in the Colony of Victoria. On the 21st September last the Melbourne Legislative Assembly adopted a motion favouring a universal union for the introduction of the decimal system in money, weights, and measures. In the same month the Trades Union Congress at Glasgow passed a resolution in favour of the adoption of the system, and directed its Parliamentary Committee to do their best to secure that result.

When it is remembered that there are over 400 millions of the globe's inhabitants using the metric system, it must be admitted that the New Decimal Association makes out a strong case for the need of reform in our present complicated system of weights and measures, especially when it is remembered that, were England now to adopt the metric system, it is quite reasonable to believe that one universal system of weights and measures would rule throughout the entire globe. Not the least argument in favour of reform in this direction is that by making the proposed change the time at present expended in our schools in learning the almost endless tables of weights and measures and sums of compound arithmetic would no longer be necessary, and a saving of a period of time equal to one year's training would be effected.

Shipbuilding Notes.

The new s.s. "The Baron," built by Messrs. John Fullerton and Co., Paisley, and engined by Messrs. Muir and Houston, Glasgow, went down the river on the 28th ult. on her official trial trip, which was in every way quite satisfactory.

The large steel screw steamer "Longships," which was launched at Dundee by Messrs W. B. Thompson and Co. Limited, to the order of the Clyde Shipping Company, Glasgow, made a trial trip on the 24th ult. The trip proved most satisfactory. A speed of fully ten knots an hour was maintained, the revolutions being 76 per minute, while the indicated horse-power was 2000.

Messrs. William Simons and Co. launched on the 22nd ult., from their shipbuilding yard at Renfrew, a barge-loading dredger. Her buckets have capacity to raise 300 tons of material per hour, and the bucket ladder dredges the vessel's own flotation to a depth of 28ft. under water level. She is fitted with compound surface-condensing engines and a steel boiler constructed for a working pressure of 90lb. per sq. in.

On the 27th ult., the s.s. "Cabo Roca," which has been built by Messrs. W. Dobson and Co. to the order of Messrs. Ybarra and Co., of Seville, was taken to sea for her official trip, fully laden with 1920 tons. The trial was highly satisfactory to all concerned, a mean speed of 9½ knots being obtained. The engines, which worked efficiently throughout, have been built by the North-Eastern Marine Engineering Company, of Wallsend.

There was launched on the 22nd ult., by Messrs. Harland and Wolff, Belfast, the steel screw steamer "Antisana," built for the Pacific Steam Navigation Company for their cargo service between Liverpool and West Coast ports of South America. The gross tonnage is 3580. Her triple-expansion engines, which have an indicated horse-power of 1900, have been constructed by the builders. The propeller will be of manganese bronze.

Principles, Curiosities, Possibilities and Limitations of the Crank Motion.—No. I.‡

How it befel that the name of the most important, most widely used, and most simple mechanical movement ever invented came to be applied to individuals whose manners, thoughts and actions depart from the general standard, and whose principles appear to have nothing consonant with the common sense of the mass of mankind, seems strange enough. Such an application of the term is not justified by facts. The crank, with its more usual accessories, the pitman and flywheel, constitute a contrivance so well adapted to the purpose desired, so simple, so supremely superior to any other known device for converting an intermittent rectilinear movement into circular motion, or a circular motion into an intermittent rectilinear motion, that a mechanical mind always contemplates it with admiration.

At the risk of being myself called a crank, I will confess that the contemplation of this movement in action, or its image called up in fancy, always produces an effect analogous to the impression made upon me by the view of a beautiful landscape, or listening to the artistic performance of a really great musical composition. The test of true beauty in fine art is, that to cultivated taste the beauty is permanent and untiring. Analogously, in the realm of the useful arts only that which is really and permanently great challenges perpetual and continued admiration. I should have little respect for the admiration of any man who could view the majestic progress of an ocean steamer, or the swift and mighty rush of a locomotive, without a thrill of pleasurable emotion, unless under the exceptional condition that he, or some other unfortunate, should be in imminent danger of destruction by its advance. These two means of intercommunication, that have revolutionised the world, representing, so to speak, the accumulated force of the human mind since man became intellectually differentiated from the brutes, each has for its chief mechanical element the crank and pitman. The eccentrics and their rods are merely a modification of the crank and pitman. Without these, I will not say a steamship or a locomotive would have been impossible; but I am very sure the speed with which seas and continents are now traversed would never have been reached.

The crank and pitman movement is one of the most striking examples of "the survival of the fittest" that can be found in the whole range of invention. In rude ages it existed in the foot-lathe, in the spinning wheel for flax, in the potter's wheel. These were its small beginnings, if, indeed, it is possible to trace its beginning. Since the days of Watt (and most notably in the time of this great inventor, and by him) mechanical substitutes for the crank have been sought. In vain has this been attempted. Even the genius of Watt failed to supplant this elegant and scientific movement. His celebrated sun-and-planet movement is probably the best substitute for the crank ever devised, except the slotted crosshead; but, given the crank and its wonderful possibilities, there was little room left for inferior contrivances. As in the vital world those animals and plants most fitted to their environment live and multiply, appropriate to themselves the food that sustains life, and starve out weaker species and varieties, so the crank, being pre-eminently adapted to the production of rotary motion from the reciprocation of a piston, had an assured future of yet undreamed importance the moment it was discovered that a reciprocating piston was adapted to the transmission of the mechanical energy stored up in the vapour of water. It may be confidently predicted that the marriage of the crank and pitman will never know divorce. Other means of generating mechanical power than the use of an elastic vapour or gas may reasonably be expected. Through the mists that veil the future some of these possibilities now appear dimly and vaguely to the eye of physicists. Steam may be abandoned. The crank and pitman may go out with the piston; but while the one remains the other will keep it company.

Of so old a movement, and one that has been so thoroughly studied, of one upon which so much has been written, what is there that has not been found out and recorded? I do not think the possibilities of this mechanical combination are exhausted. I am certain that some of them are at least not generally known, and if known at all I do not know where any account of them exists in old or new treatises. But an ancient sage of high reputation for wisdom has said that "there is nothing new under the sun." I shall therefore not be surprised to find that a description of some peculiar applications of the crank that I propose to present in this series of articles has been anticipated by someone before me, and if by this means the records that contain them are brought to common knowledge, what I shall say will have served at least a literary and historical purpose.

The crank and pitman before the days of Watt, though a useful movement, showed no promise of its future extended application. So any new or old mechanical movement may lie almost or wholly unapplied till the time comes for its world-wide adoption. The present inutility of a mechanical device should, therefore, not always relegate it to the scrap heap of discarded and impracticable ideas. An invention may be of no present value, simply because it is either behind or in advance of the age. In either case the wheel of time may bring around a period when that which is now behind the age may again find a useful application, or when that which once anticipated a future want becomes in universal request.

To say the least, it is always a profitable study to investigate to their utmost limit the principles and effects of any important mechanical movement. The analytical powers of the mind are strengthened by the exercise, and such an investigation rarely fails to throw new light upon points that already were thought to be fully understood by the investigator. Moreover, the interest felt in going exhaustively to the very bottom of a subject is a sure indication of the "get there" quality of mind that is always possessed by a notably able mechanic. Content with half-knowledge is the indelible mark of mediocrity. Of that which is in the immediate line of our calling, in which we hope to achieve reputation and command good position, we cannot know too much; impracticabilities are as important to know as practicabilities. The important thing is that we should *know* something, know *all that we can* about the things that we must deal with daily, despising neither theoretical nor practical knowledge; neither the information obtainable from books, nor the inestimable teaching of experience. But books on mechanics give us, or should give us, results of experience as well as theoretical discussion; and through the study of books, if well selected and carefully perused, we may check and reinforce our own experience by the experience of others.

As a preliminary to the presentation, and a preparation for the proper consideration of the motions possible of attainment by the use of the crank and pitman, it will be proper to restate some principles that have been thoroughly demonstrated, practically as well as theoretically, and which are now found in all standard works on the steam engine. In doing this the effort will be made to convey ideas in simple, concise language, with the least possible resort to mathematical methods; and I will premise, without further preamble, that no formulæ or rules beyond the reach of ordinary arithmeticians will be used in this discussion. It is to avoid mathematical formulæ that I restate principles rather than quote from well-known treatises on the subject.

In the succeeding article these preliminary principles will be considered.

(To be continued.)

‡ By Leicester Allen, in "Engineering.

The Value of the Steam Jacket.

(Continued from page 244, vol. xii.)

Nos. 47—51. Experiments on a single-cylinder vertical experimental engine at Bermondsey, by Mr. Bryan Donkin, jun.

The following steam jacket experiments were made at Bermondsey, on a single-cylinder vertical experimental engine, diagrams 14 and 15, under different working conditions and with various arrangements of jacketing. The cylinder is 6in. diameter, and the stroke 8in. The slide valve is provided with a Meyer variable-expansion valve. The body and both ends of the cylinder are jacketed, as is also the valve-chest cover; and steam is supplied to each of the four jackets direct from the boiler by a separate pipe. By a special arrangement, the water from the cylinder body jacket was divided into two portions, and the weights of these are given separately. The first portion consists of the steam condensed on the inner vertical surface of the jacket, and is due to the heat passing through the walls into the cylinder, almost all of which is usefully employed in keeping the temperature of the cylinder nearly equal to that of the steam in the jacket. The other portion consists of the steam condensed on the outer vertical surface of the jacket, and is due to the heat

uselessly radiated outwards owing to imperfect external covering. This loss should of course be reduced to a minimum, and in these experiments a layer of good non-conducting material was placed round the cylinder for this purpose.

Observations of the temperatures of the cylinder walls were made throughout the trials, following the method already published in Proceedings Inst. Civil Engineers, vol. c., 1890, page 347. These temperatures were taken by small thermometers inserted in $\frac{1}{8}$in. holes, drilled into the metal walls and filled with mercury. The temperature of the cylinder walls was much higher with steam in the jackets than without.

Experiments were made not only with and without steam in the jackets, but also with all the jackets filled up with water, which was allowed to assume a normal temperature before commencing the trial; a trial was also made with a vacuum in the body jacket. When no steam is admitted into the jackets, the air in them gets gradually hotter, being heated by the cylinder walls, until it reaches a normal temperature. The same thing occurs when cold water is admitted into the jackets; it gradually becomes hotter, and then remains at a constant temperature.

Experiments were made at two different speeds—about 218 and 115 revolutions per minute. In order to shorten the duration of the trials, the engine was fitted with a surface condenser to measure the feed-water; and it was found that trials lasting for half-an-hour agreed satisfactorily with those of three hours' duration. The steam-pressure and cut-off were kept constant throughout the whole of the experiments with the exception of No. 50, in which the cut-off was varied. A brake was used to absorb the power.

Five experiments were made on this engine, four condensing and one non-condensing. Experiment No. 47 consisted of four trials at about full speed, with steam in all the jackets, without steam in any of the jackets, with water in all the jackets, and with a vacuum in the body jacket. Experiment No. 48 consisted of two trials at about half speed, with and without steam in all the jackets. Experiment No. 49 consisted of two non-condensing trials at about full speed, with and without steam in all the jackets. Experiment No. 50 consisted of 12 trials, all at full speed, made in pairs, one unjacketed and one jacketed, with six different degrees of expansion, in order to determine how the changes in the ratio of expansion would affect the value of the steam jackets. In experiment No. 51, steam was admitted to the body jacket and shut off again during the experiment without stopping the engine, in order to ascertain the effect of this upon the speed of the engine, the load on the brake being kept constant. In all the experiments, the feed-water always included the whole of the jacket water.

Experiment No. 47: Four trials with a different media in jackets.—The first trial was made without steam in any of the jackets—that is, with hot air in all the jackets,—and lasted for 34min. The consumption of feed-water was at the rate of 41·23lb. per I.H.P. per hour. The four trials were all made at a mean speed of about 218 revolutions per minute, condensing, and at a cut-off of $\frac{4}{16}$ths.

The second trial was made with steam in all the jackets, and lasted for 52min. The consumption of feed-water, including jacket-water, was at the rate of 28·39lb. per I.H.P. per hour, showing a saving in feed-water of 41·23 – 28·39 = 12·84lb. per I.H.P. per hour, or a decrease in consumption of 31·1 per cent. due to the action of steam as compared with hot air in the four jackets. The mean temperature of the internal part of the cylinder walls was 28° higher with steam in the jackets than with hot air. The condensed water from the various jackets was as follows:—

Jacket.	Condensed Water per I.H.P. per hour.
Body jacket, inner wall ..	0·69lb.
" outer wall ..	0·68
Top-end jacket	0·15
Bottom-end jacket	0·41
Valve-chest jacket	0·18
Total jacket-water	2·11lb.

The total quantity of steam condensed in the jackets was therefore 2·11lb. per I.H.P. per hour, which is equivalent to 7·44 per cent. of the total feed-water. Thus for every lb. of steam condensed in the jackets there was a net saving in feed-water consumption of 6·11b. The following table shows the effect of the different jackets on the feed-water consumption, as determined by another experiment.

The third trial was made with hot water in all the jackets, and lasted for 22½min., the water in the jackets being allowed to assume a normal temperature before the observations were commenced. The consumption of feed-water was at the rate of 46·27lb. per I.H.P. per hour, showing a difference in feed-water consumption of 46·27 – 41·23 = 5·04lb. per I.H.P. per hour, or an increase of 12·2 per cent., due to the presence of hot water in the jackets, as compared with hot air.

Arrangement of Jacketing.	Feed-water, including Jacket-water. Consumption per I.H.P. per hour.	Saving due to Steam Jackets. Per I.H.P. per hour	Percentage of 41·2.
	lb.	lb.	per cent.
Without steam in any of the jackets	41·2	—	—
With steam in two end jackets only	37·0	4·2	10·2
With steam in body jacket only	30·1	11·1	26 9
With steam in all four jackets	28·4	12·8	31·1

In the fourth trial, which lasted for 26min., a vacuum of 12·85lb. per sq. in. below the atmosphere was maintained in the body jacket by putting it in direct communication with the condenser, the other three jackets being open to the air. The consumption of feed-water was at the rate of 38·01lb. per I.H.P. per hour, showing a saving in feed-water of 41·23 – 38·01 = 3·22lb. per I.H.P. per hour, or a decrease of 7·8 per cent. due to maintaining a vacuum in the body jacket, as compared with hot air in all the jackets. This trial with a vacuum in the body jacket was made with the intention of lowering the temperature of the cylinder walls; but a little reflection showed that there was no medium to convey the heat from the hot metal walls to the cooler condenser. The walls were found to remain at a temperature of 264° F., without parting with their heat, although exposed to the much lower condenser temperature of 130° F. This has since been confirmed by further experiments, and shows a practical result which is not unimportant. The cylinder walls were rather hotter with a vacuum in the body jacket than with hot air in all the jackets, and external radiation was probably diminished.

A trial, not recorded in the tables, was also made on this engine, with the barrel jacket filled with mineral cylinder oil kept at a temperature of 375° F. by means of gas jets, and with steam in the other three jackets. The trial was made condensing, with a cut-off at $\frac{3}{16}$ths. The consumption of feed-water, including the small quantity of jacket-water which was condensed during the trial, was at the rate of 28·86lb. per I.H.P. per hour, which is slightly higher than in the second trial of experiment No. 47, the corresponding trial with steam in all the jackets.

Experiment No. 48: Two trials at half-speed with and without steam in jackets.—Trials were made at a mean speed of about 116 revolutions per minute, condensing, and at a cut-off of $\frac{3}{16}$ths. With the exception of the speed, which was a little more than half, all the conditions were the same as those for the first two trials of Experiment No. 47.

The trial without steam in any of the jackets lasted for 36 minutes. The consumption of feed-water was at the rate of 46·25lb. per I.H.P. per hour.

The trial with steam in all the jackets lasted for 28 minutes. The consumption of feed-water, including jacket-water, was at the rate of 30·43lb. per I.H.P. per hour, showing a saving in feed-water of 46·25 – 30·43 = 15·82lb. per indicated horse-power per hour, or a decrease in the consumption of 34·2 per cent. due to the action of steam as compared with hot air in the jackets. The mean temperature of the internal part of the cylinder wall was 31° higher with steam in the jackets than without; and for these two trials the temperatures were a few degrees higher than in the first two trials of Experiment No. 47, when the speed was about double, all the other conditions being the same. The total condensed water from the jackets was as follows:—

Jacket.	Condensed Water per I.H.P per hour.
Body jacket, inner wall ..	0·68lb.
" outer wall ..	0·68
Top-end jacket	0·32
Bottom-end jacket	0·50
Valve-chest jacket	0·25
Total jacket-water	2·43lb.

The total quantity of steam condensed in the jackets was therefore 2·43lb. per I.H.P. per hour, which is equivalent to 7·99 per cent. of the feed-water. Thus for every lb. of steam condensed in the jackets there was a net saving in feed-water of 6·51b.

Comparing these results with the first two trials in Experiment No. 47, in which all the conditions were the same with the exception of speed, the effect of the steam-jackets at the reduced speed is seen to be increased by about 3lb. per I.H.P. per hour, thus:—

Speed of Engine.	Saving due to Steam Jackets per I.H.P. per hour.
218 revs. per minute	12·84lb.
116 " "	15·82
Increase in saving at reduced speed	2·98lb.

(To be continued.)

Catalogues, Price Lists, Etc.

Engineers, Tool Makers, Metal Merchants and others are invited to forward Catalogues, Pamphlets, Circulars, Price Lists, etc., for notice in this column.

MR. JAMES MCRAE, Crabbery-street, Stafford, has issued a set of coloured drawings of various engine and machine details. The set includes examples of boiler, fire-box, and flue riveting, connecting and coupling rods, pistons, pedestals, cross-heads, eccentrics, steam cylinders, air pumps, steam pumps, etc. Mr. McRae has had a long, practical experience, both as a mechanical engineer and science master, and certainly both in general design and detail these plates reveal a thorough practical acquaintance with the subject, and they are, therefore, calculated to be of great service to young draughtsmen and apprentices, as well as to students preparing for the Science and Art Department and Board of Trade examinations.

Messrs. LISTER AND CO., Keighley, have issued a neat little circular, "Notes on Milling." The primary object of the publication is apparently to draw attention to the capabilities of this firm's handy little milling machine, but it also contains a deal of useful data and memoranda on the milling process generally. In addition to a number of general notes on the care of cutters, cutting speeds and feeds, there are given rules for cutting spirals, tables for dividing by wheel cutting attachment and by the spiral head, etc. The information given is valuable, and the list will doubtless be carefully preserved in the office or workshop in consequence.

Messrs. HENRY R. WORTHINGTON, of New York, have favoured us with a copy of their recently-published volume, "Duty and Capacity Tests of Worthington High-duty Pumping Engines." This consists of a collection of tests of these well-known pumping engines, many of which have already appeared in various English or American publications. In all 16 tests are detailed, and as the full particulars are given in each case, the volume is an exceedingly interesting and instructive one.

The special annual number of "Timber" is again to hand. We do not think the present issue is quite up to the standard of last year's production, but it is unquestionably a most marvellous production, whether viewed from a literary or an artistic standpoint. A special feature in this year's issue is three large groups of photographs of well-known members of the timber trade.

"Questions in Applied Mechanics" is the title of a pamphlet published by Mr. WALLACE BENTLEY, Halifax. A number of classified questions are given, these being in most cases accompanied by answers. The questions appear to be intended for students preparing for the elementary stage of the Science and Art Department's examination, and to these the book will no doubt prove of service.

Messrs. E. AND F. N. SPON have issued the 1892-93 edition of their "Engineer's and Contractor's Illustrated Book of Prices of Machines, Tools, Ironwork, etc." Most of the leading makers are well represented, and a copious index is appended. The volume, which is a somewhat bulky one, is handsomely bound.

From the CLAYTON AIR COMPRESSOR WORKS, New York, we have received a copy of their new catalogue of single and duplex air compressors, variously arranged for driving by steam, belts, gearing, or water power. Illustrations and particulars of rock drills, blowing engines, mine pumps, vacuum pumps, etc., are also given.

Messrs. JOHN SHAW AND CO., Maryhill Ironworks, Glasgow, have issued a new illustrated price list of cast-iron pipes. The diameter, thickness, weight, and price, are given in both English and French denominations. The addition of the latter feature will prove of considerable advantage.

Mr. H. A. HOBDAY, High-street, Chatham, has sent us a copy of his neat little catalogue of tools and appliances of various kinds. It is well printed and bound, and is altogether a pleasing contrast to the usual type of price lists of this description.

The twentieth annual issue of CALVERT'S "Mechanic's Almanac" is, we think, scarcely up to the usual standard. It contains articles on Patent Law, the Chemistry of Building Materials, Traders and Trading, Wheel Teeth, etc.

Messrs. FURNIVAL AND CO., Reddish, have favoured us with a copy of their elegant catalogue of printing machinery of various kinds, guillotine cutting machines, calendering and numbering machines, etc.

Trade Notes.

The Austrian Small Arms Factory, Vienna, has declared a dividend of 19 per cent.

Messrs. Siemens and Halske, of Berlin, are erecting a central station at Pirna, Saxon Switzerland.

Messrs. M. Powis, Bale and Co., London, have secured a large order for stone-working machinery for South Africa.

Messrs. Napier, Shanks and Bell, Yoker, have contracted to build a triple-screw steamer, to be fitted up and shipped to China.

Messrs. Charles Cammell and Co., Sheffield, have booked an order for 2000 tons of steel rails. They will be made at the Worthington Mills.

Messrs. T. Oswald and Son, of the Steel Works, Milford Haven, have obtained the order for the repairs to the North German Lloyd Company's disabled steamer "Spree."

Messrs. Schuckert and Co., of Nuremberg, have recently completed a large electric power transmission plant at the Falck Colliery, Bockwa, Saxony.

Messrs. Victor Coates and Co., of Belfast, have obtained an order for a set of triple-expansion engines for Messrs. Lindsay, Thompson and Co., flax spinners, Belfast.

The directors of the Naval Construction and Armaments Company, Barrow, have declared an interim dividend of 2½ per cent. on the six months' working ended December 31.

The Town Council of Bournemouth have decided to light the pier and pleasure grounds with electricity, and have accepted the tender of Messrs. Goddard, Massey and Warner, of Nottingham.

The tender of M. Eiffel, the designer of the Eiffel tower, for the construction of a large iron bridge across the Riva Neva, has been accepted by the municipality of St. Petersburg. It is estimated to cost 26,000,000 roubles.

Messrs. Gourlay Brothers and Co., Dundee, have received orders to fit three large steamers belonging to Messrs. Gordon and Co., London, with new boilers and triple-expansion engines.

The fusion of the well-known German firms of Krupp and Gruson was agreed to at a meeting held in Berlin on the 23rd ult. The Krupp firm takes over the management of the Madgeburg establishments, and guarantees to the shareholders of the Gruson Company a dividend of 9 per cent. for the period of 25 years.

Messrs. R. and W. Hawthorn, Leslie and Co., of Hebburn, Newcastle-on-Tyne, have just booked an order for a large steamer. This, with the two North German Lloyd's boats secured a short time ago, and two or three other cargo steamers make a total of something near 50,000 tons of new work booked on the Tyne in the past few weeks.

Messrs. Gwynne and Co., the well-known engineers, of Essex-street Works, Strand, London, W.C., have acquired the entire business, patents, and rights of the Pilsen Electric Company, which will in future be carried on as Messrs. Gwynne and Co.'s electrical department at their new works, Brooke-street, London, E.C., in large and well-equipped premises.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 391, Strand, London, or New Bridge-street, Manchester.

Wheel cutter in metal only. Every description of gearing. R. CHIDLAW, 43, City-road, Manchester.

Having regard to the enormous circulation of THE MECHANICAL WORLD, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if MECHANICAL WORLD readers will kindly bear this in mind as occasion arises.

The Belfast Mechanical and Engineering Association.

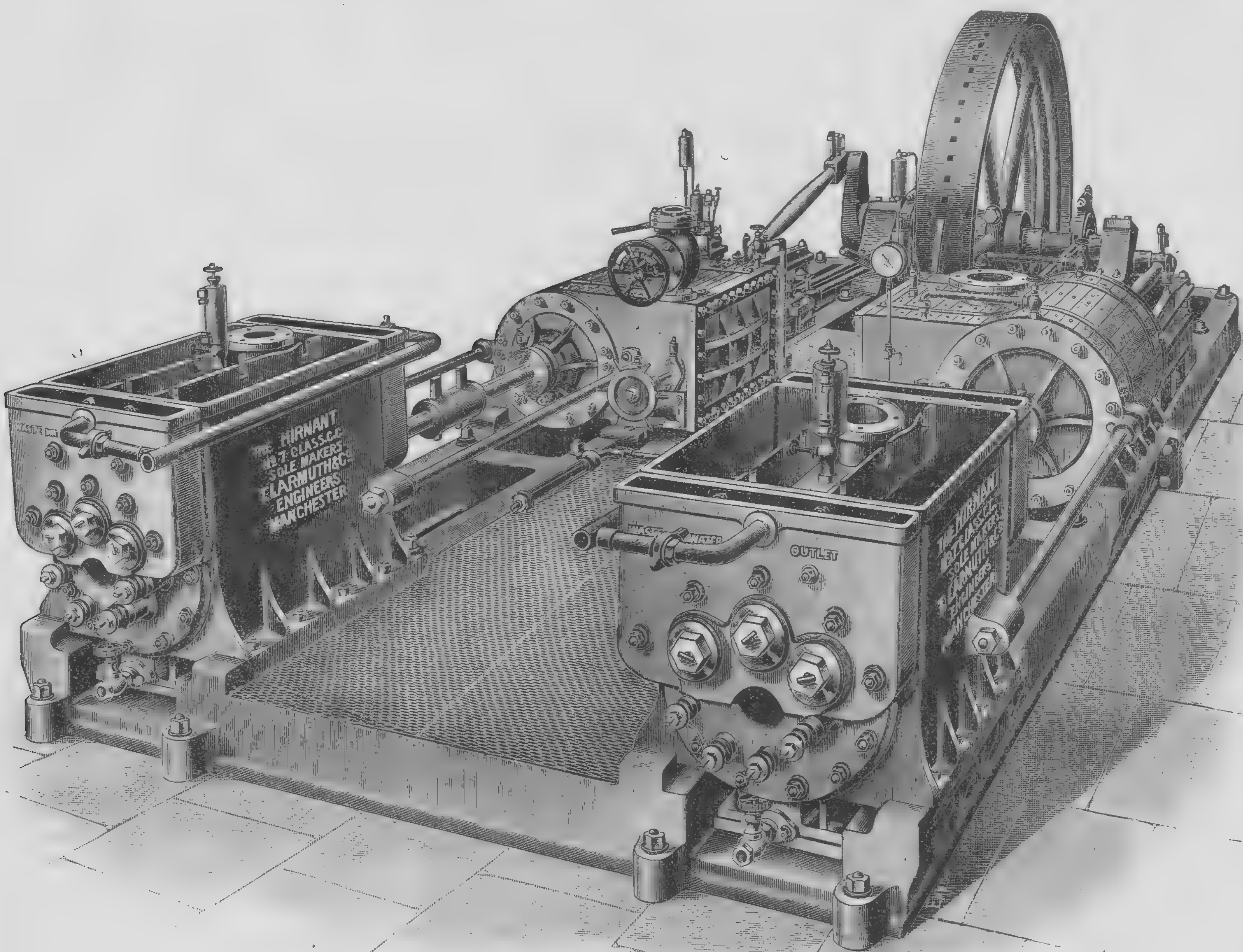
THIS association, on Friday, the 30th ult., held the usual monthly meeting in their rooms, Garfield Chambers, at which a very interesting paper on "Modern Milling" was read by Mr. Jas. F. Breach. Mr. Jerdan Nichols, the president, occupied the chair. After the routine business had been disposed of, Mr. Breach proceeded with his paper, in which he traced the progress and history of milling from prehistoric ages down to the advent of roller milling. He recounted how the modern method of milling arose, and in lucid manner treated the subject from the engineering, mechanical, and practical points of view, and discussed all the departments of a modern mill. The various ways of storing wheat were generally examined, as were also the cleaning and preparation of the wheat for grinding. The nearly obsolete practice of grinding by millstones was contrasted with the modern process by rolls, and the superiority of the latter was conclusively shown. Finally he referred to the transmission of power in flour mills and the choice of a motor, emphasising the essentiality of judgment in this respect where economy is a consideration. The paper was copiously illustrated, and was favourably criticised by Messrs. Gamble, Irvine, Bell, and Nichols, to whom Mr. Breach replied in fitting terms.

ON the 31st ult. the Naval Construction and Armaments Company Limited launched from their yard at Barrow the second of two steamships building for the West India and Pacific Steamship Company, Liverpool. She is built of steel, and her measurements are:—Length, 380ft.; breadth, 44ft.; depth, moulded to awning deck, 37ft. The deadweight carried will be about 5890 tons. She will be propelled by direct-acting triple-expansion engines, with cylinders $25\frac{1}{2}$in., $42\frac{1}{2}$in., and 72in. diameter, by 51in. stroke. Steam will be supplied by two boilers, working at a pressure of 200lb.

"Hirnant" Air Compressor and Rock Drill.

THE use of compressed air for the ventilation of mines, the working of rock drills in driving headings of mines, and for a large number of other purposes, is increasing very rapidly. As a consequence, the machines in which compressed air is used have latterly had a considerable amount of attention paid to them by makers, with a view to increasing their durability and also to decrease the consumption of air without loss of efficiency. In some mining districts, where the cost of fuel is considerable, the saving of air is of great importance; whilst in others no great attention is paid to this item, as the air, after being used, say, in the rock drills, is afterwards employed to assist in the ventilation of the mine.

The accompanying cuts show a complete mining plant, known as the "Hirnant," consisting of a pair of air compressors and a rock drill. These are made by Messrs. T. Larmuth and Co., Todleben Ironworks, Salford, Manchester, who have a very extensive connection in this class of work. The air compressor illustrated has recently been despatched, along with six drills of the type shown, to Johannesburg, South Africa, to the order of the Meyer and Charlton Gold Mining Company, where, in addition to operating the drills, the compressor is to be used for working the pumps of the mine. As will be seen, the compressor is of the horizontal compound type, the high-pressure cylinder being $14\frac{3}{4}$in. diameter, and low-pressure cylinder $25\frac{1}{2}$in. by 3ft. stroke, the steam chests being arranged on the inside. The cranks are placed at right angles, with the flywheel between them. The latter is 10ft. 6in. diameter, weighs $5\frac{1}{2}$ tons, and is notched for operating by hand starting gear. The high-pressure cylinder is fitted with a hard cast-iron liner, forming a jacket for steam at boiler pressure round the cylinder. This jacket is so arranged that the condensed water can be drained away from both the cylinder jacket and the steam chest by one trap. The valves for the cylinder consist of one main and two expansion slide valves, which are adjusted, whilst the compressor is running, by a hand wheel, seen projecting from the front end of the steam chest. The low-pressure cylinder is fitted with an ordinary double-ported slide valve. The ratio of expansion is indicated on a bronze index plate behind the hand wheel.



"HIRNANT" AIR COMPRESSOR AND ROCK DRILL.

All the valve spindles, piston rods, crossheads, connecting rods, eccentric rods, cranks, crankshaft, and other rods are made of the best mild steel.

The two air cylinders are fixed at the back of the high and low-pressure steam cylinders, and, as will be seen, are operated by an extension of their piston rods, the latter being strongly connected by a muff coupling and cotters. Each air cylinder is 18in. diameter, and is cast in a tank, which forms a water jacket round each working barrel, whilst a jacketed cover is placed at each end of the barrel. The jacketed covers form chambers for four inlet valves and three delivery valves. The latter are connected by a port provided with an outlet branch in the centre. Water for cooling purposes is delivered in the bottom of the air cylinders, thence through perforated plates, in order to distribute it. A portion of the water passes through the jackets of each cylinder and over six small weirs at the top, and finally through the waste water outlets at each end.

A very important feature in the "Hirnant" compressor, and one which tends to promote economy in compressing the air, is the reduction of clearance space in the air cylinder. This is attained by constructing the inlet valve so as to retain all the lubricant used in the air cylinder and with it, to nearly fill the clearance space. Since the latter is but $\frac{1}{16}$in., it will be seen that practically the air is compressed to the highest possible limit.

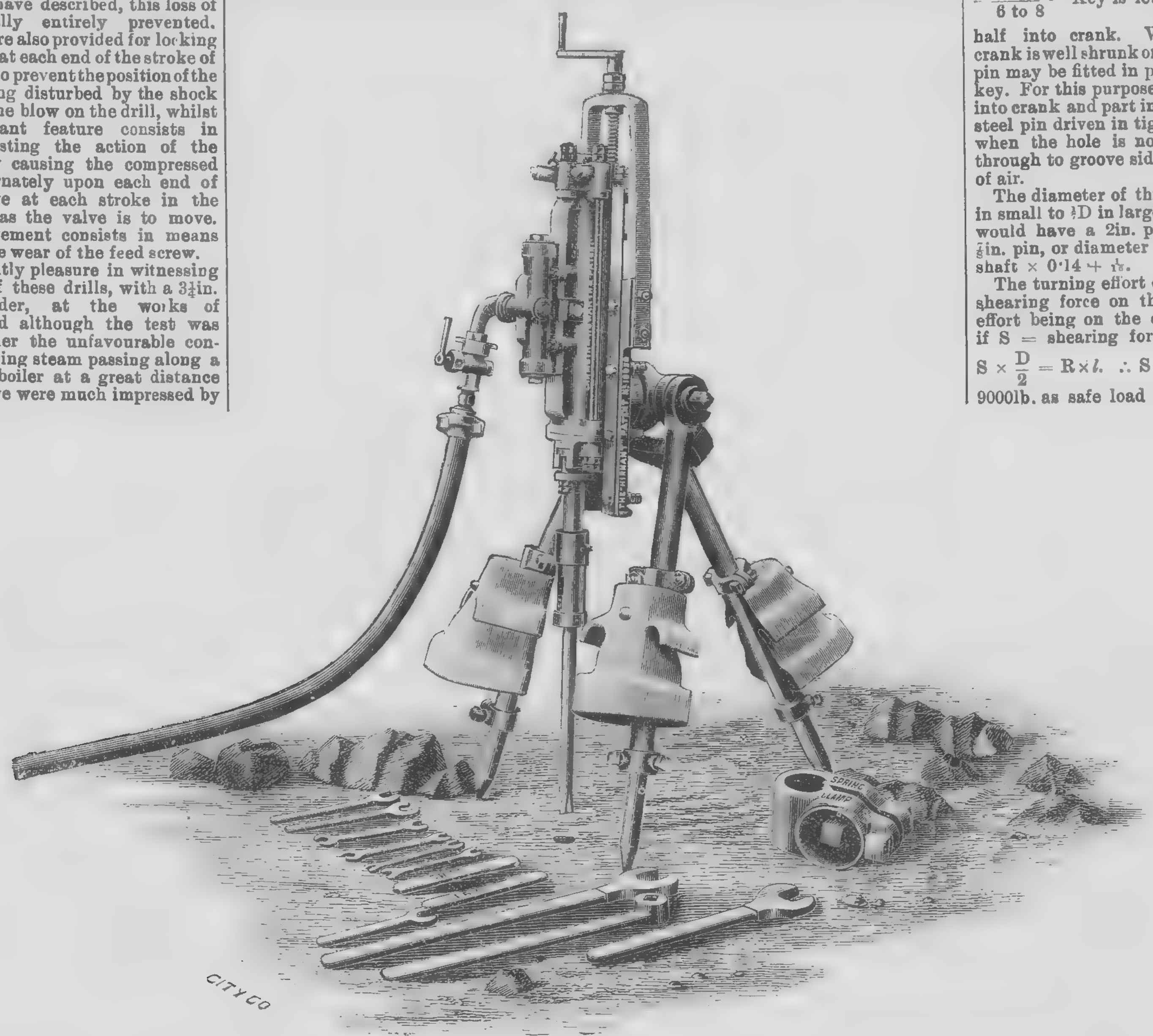
A cast-iron receiver pipe, having a capacity of about one and a quarter times that of the low-pressure cylinder, connects the high-pressure to the low-pressure steam chest. This pipe is fitted with a reheating coil of copper pipe, provided with a stop valve, the steam being supplied from the high-pressure steam chest; there is also an expansion trap to remove all condensed water. The receiver pipe is also provided with an expansion trap for the same purpose. A lever push valve, taking steam from the boiler side of the starting valve, is used to admit steam into the receiver pipe and low-pressure steam chest, for starting purposes.

The whole of the mechanism is mounted on a solid cast-iron bed so as to keep the parts well in line and free from vibration. The compressor is designed to develop about 200H.P. when working with two air cylinders, or 108H.P. with one, the steam pressure being 140lb. and the air pressure 70lb., the number of revolutions 80 per minute.

The "Hirnant" rock drill, shown in Fig. 2, is a well-designed tool. All the joints and slides are carefully machined and fitted, special care being taken to prevent any of the parts coming loose by vibration or shock. An important feature in this drill, and one that cannot be lost sight of where economy of air is a consideration, is the provision of a long valve box and short inlet ports for the steam or air. The valve box in the drill shown is, however, but about half the length of the new box, whilst the ports are of the ordinary length. In the new arrangement the valve box is about as long as the cylinder, whilst the ports are cut direct through the metal at each end of the valve chamber at right angles to the axis of the drill. By this means the ports are only equal in length to the thickness of the metal, and a considerable saving of air is thereby effected. This will be more readily understood when we say that ordinary rock drills have a slide valve, the ports of which, admitting air or steam to the drill cylinder, have an average capacity of 8 cubic inches, which has to be filled with air or steam at each stroke of the drill piston. A rock drill

working with air at 60lb. pressure makes about 800 strokes per minute, and at this speed it requires 6400 cubic inches of air to fill the ports. This volume of air represents a speed of 25 revolutions in a single-acting air compressor with a cylinder 10½in. diameter and 15in. stroke, or over 3⅜ cubic feet of air at 60lb. pressure, which is entirely wasted, per minute. With the ports arranged as we have described, this loss of air is practically entirely prevented. Arrangements are also provided for locking the valve tappet at each end of the stroke of the piston, so as to prevent the position of the piston valve being disturbed by the shock resulting from the blow on the drill, whilst another important feature consists in means for assisting the action of the valve tappet by causing the compressed air to act alternately upon each end of the piston valve at each stroke in the same direction as the valve is to move. Another improvement consists in means for taking up the wear of the feed screw.

We had recently pleasure in witnessing a test of one of these drills, with a 3¼in. diameter cylinder, at the works of the makers, and although the test was carried out under the unfavourable condition of employing steam passing along a hose from the boiler at a great distance from the drill, we were much impressed by the result.



The "Hirnant" Rock Drill.

The drill bit used was of the best tool steel, carefully made and tempered. It was 1⅝in. diameter, and the boulder to be drilled, and which was sunk in the yard, was a piece of Chirk granite from the quarry of the Ceiriog Granite Company, Chirk, North Wales, one of the hardest granites known. A perfectly round hole 13in. in depth was drilled in two minutes—a remarkable performance, when it is considered that in addition to the drawback of employing steam at a great distance from the boiler, there was also the disadvantage of the boulder not being in solid ground. In fact, after drilling the hole, it was found that the boulder had sunk 1in. below the surface of the surrounding ground, a fact which must be taken into account in considering the trial; moreover, a very appreciable amount of the force of each blow was absorbed by the ground, and therefore did no useful work. The test, we consider, was highly satisfactory under the circumstances, and we have every reason to believe that a much greater depth of hole would have been drilled under ordinary every-day conditions.

Both the compressors and drills constructed by this firm are substantially made and highly finished. Messrs Larmuth will be pleased to furnish additional particulars upon application.

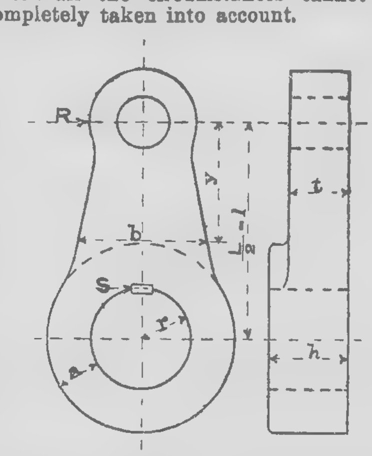
The highest recorded speed made by a railway engine has just been reported from the United States, where, on the line of the Philadelphia and Reading Railway—the New York division—a mile was covered in 37sec., or at the rate of 97¼ miles an hour. Nor was this one mile run the only remarkable part of the performance, for the next mile was made in 38sec., the third in 39sec., the fourth in 40secs., fifth in 41secs.; five consecutive miles were later on made in 205sec., an average of 87·8 miles an hour. The train was a regular express, consisting of ordinary and Pullman carriages.

The Design and Construction of Stationary Engines.—XLIV.

Cranks.—The reciprocating motion of the piston is converted into circular motion by means of the crank, which in the ordinary form consists of an arm, with a boss at each end, one to fit on to the crankshaft and the other to receive the crankpin.

Fig. 188 is a form of crank most commonly employed for engine work. The radius of the crank arm is half the stroke of the engine, and is measured from the centre of the crankpin to the centre of the crankshaft.

Proportions of Cranks.—The proportions of cranks which obtain in practice have been evolved from practical experience, and are more to be relied upon than the results of any theoretical investigation in which all the circumstances cannot be completely taken into account.



Design, etc., of Stationary Engines: Fig. 188.

The main elements of the question are, however, very simple, and may here be briefly stated, leaving the reader, if so inclined, to consult more elaborate investigations of the subject in theoretical works.

The crank arm may be considered as a lever, acted on by a force applied at the crankpin.

Let t = thickness of crank in direction parallel to the axis, b = breadth at a section y inches from crankpin centre, and R = total load on crankpin. The bending moment M at that section will = R × y.

And applying the formula for the moment of resistance of rectangular beams, we have $\frac{t\,b^2}{6} = \frac{M}{f}$ and $t = \frac{6\,M}{b^2 \times f}$.

It is usual to assume a ratio between t and b, which in practice varies from $\left(\frac{b}{t}\right)$ 2 to 3. Adopting a value for b, t can be found from the formula given above. To find the thickness of the eye a: If L = length of stroke, R = total load on crankpin, f = safe tensile strength of material = 5000 for iron, we have, taking moments about the axis of the shaft, $R \times \frac{L}{2} = f\,a\,h\left(r + \frac{a}{2}\right)$ and

$$a = \sqrt{\frac{L\,R}{h\,f} + r^2} - r.$$

Fixing Cranks.—Cranks are usually shrunk on to shaft and pin. Some firms force them on by hydraulic pressure, but as a rule this latter method is not always satisfactory, the jar and vibration in working being very apt to shake them loose. It is better and more usual to shrink them on to place.

With regard to amount of shrinkage allowed for cranks, this varies in different shops from $\frac{1}{500}$ to $\frac{1}{800}$.

The tension on the crank eye round the pin will be found by multiplying the modulus of elasticity of the material by the extension of the material. The modulus of elasticity of cast iron may be taken at 20,000,000, wrought iron 28,000,000, and mild steel at 30,000,000. For cast iron we may take the value $\frac{1}{800}$; we have then

$$\frac{1}{800 \times 3{\cdot}1416} = \frac{1}{2513} \text{ of the circumference,}$$

and the stress on the inside layers of the metal = 20,000,000 × 0·0004 = 8000lb. For wrought iron we may take the value $\frac{1}{650}$ and for steel $\frac{1}{700}$, giving in the former case for wrought iron about 14,000lb., which is well within the elastic limit of the material.

A good plain practical rule for general purposes is to bore the hole for shaft and pin as near as possible to the exact diameter of shaft and pin, or slightly over the size, then heat gently, slip on to place, and when the crank cools it will be found to have a good grip without unduly stressing the material round the eye.

The crank is generally fixed on to the shaft by means of a key, in addition to being shrunk on.

The key has usually a breadth = $\frac{D}{3 \text{ to } 4}$. D = diameter of hole in crank, and a depth = $\frac{D}{6 \text{ to } 8}$. Key is let half into shaft and half into crank. When, however, the crank is well shrunk on to the shaft, a round pin may be fitted in place of a rectangular key. For this purpose a hole is drilled part into crank and part into shaft, and a round steel pin driven in tight, care being taken when the hole is not drilled completely through to groove side of pin for the escape of air.

The diameter of this pin varies from ⅛D in small to ¹⁄₇D in large shafts. A 14in. shaft would have a 2in. pin, and a 4in. shaft a ⅞in. pin, or diameter of pin = diameter of shaft × 0·14 + $\frac{1}{16}$.

The turning effort on the crank exerts a shearing force on the key, the centre of effort being on the circumference. Then if S = shearing force on key, we have $S \times \frac{D}{2} = R \times l$. ∴ $S = 2R\frac{l}{D}$. Allowing 9000lb. as safe load on the key, and that the crank is loose on the shaft, the area of the section of the key parallel to the shaft must not be less than $\frac{S}{9000}$.

Forms of Cranks.—The design of cranks does not admit of much variety of form. In former years, when lower pressures of steam were employed, cranks were most often made of cast iron, and this material is still sometimes used by makers of cheap, common forms of engines.

With the high pressures of steam now ruling, it is not safe to use cast iron, especially for large cranks, on account of its low tensile strength and the uncertainty of obtaining a good, sound casting. When cast iron is employed, it is better to make the crank in the form of a disc. When the crank is made of cast iron the section of the arm is usually rectangular; sometimes it is trough shaped, this latter form also being often used in cast-steel cranks.

(To be continued.)

It is reported from Berlin of the first hackney carriage provided with an electric light, that the novelty has had such an effect on the cab-drivers in general that they are all demanding the new light for their carriages.

Since the telephone service of Sweden was taken over by the Government this method of communication has been greatly developed. So much has this been the case that there is scarcely a third or fourth-rate town which is not connected with the trunk lines between Stockholm and Malmö, and between Stockholm and Gothenburg. Moreover, the service is very efficient, owing mainly to the employment of a metallic circuit, or the double wire system, whilst the annual rental is low. A further development of the service is now under the consideration of the Governments of Sweden and Norway, who propose to establish telephonic communication between Stockholm and Christiania. If this is carried out the whole Scandinavian peninsula—that is, a district of 700,000 square kilometres superficial area—will be placed in intercommunication.

Metal Trade Memoranda.

The Old Lodge Tinplate Works, Llanelly, which have been idle for some months, will resume operations early this year.

It is calculated that the production of the Scotch blast furnaces this year will amount to between 950,000 and 1,000,000 tons.

Messrs. Sir W. B. Samuelson and Co., Newport Ironworks, Middlesbrough, are making experiments with the Saniter process of desulphurising pig iron.

During the month of November Spain exported to Great Britain 151 tons of copper ore and 2960 tons of regulus and precipitate, as compared with 2557 tons and 3326 tons respectively in November, 1891.

The demand for steel rails is improving, in the United States. Prices there have fallen to about £6 per ton, and the preparation of the railways for the enormous traffic of next year is forcing orders into the market. One order for 10,000 tons for the Far West is reported to have been given to an English firm.

M. Moissan has succeeded in obtaining a temperature of 3000° C. with an electric furnace of lime bricks, using high-tension currents, the highest temperature obtained previously in the oxygen furnace of Deville and Dubray being about 2000° C. Near 2500° C., M. Moissan found that lime, strontian and magnesia crystallised in a few minutes. If the temperature rises to 3500° C. the walls of the furnace melt. With the current of 50H.P. the exterior of the furnace becomes red hot in a few minutes.

New Companies.

A. Ransome and Co. Limited.—This company was registered on the 28th ult., with a capital of £50,000, in £10 shares, to take over the business and assets of the firm of A. Ransome and Co., and Ransome, Josselyn and Woods, upon the terms of an agreement dated the 26th ult., and to carry on the trade of ironfounders, mechanical engineers, and manufacturers of wood-working and other machinery. The number of directors is not to be less than 2, nor more than 5; qualification, 500 shares for each managing director, and £1000 for every other director. Allen Ransome, F. Josselyn, and V. S. Woods are to receive £1000 per annum respectively. Registered by Field, Roscoe and Co., 36, Lincoln's Inn Fields, W.C.

Official Gazette.

Partnerships Dissolved.

F. Edwards, G. Robertson, and D. J. Morgan, under the style of the Central Engineering and Ship Repairing Company, Bute Docks, Cardiff, ship repairers.

John and James Horrocks, under the style of John Horrocks and Son, Manchester, machinists.

E. A. Tyzack, W. Tyzack, J. W. Gould, and E. B. Tyzack, as trustees of the late W. A. Tyzack and W. Tyzack, J. Havenhand, J. W. Gould, and F. B. Tyzack, under the style of W. A. Tyzack and Co., Sheffield, manufacturers of steel saws, scythes, files, and machine knives, and general merchants or dealers in Sheffield hardware.

R. Wright, W. H. Allen and R. W. Allen, under the style of W. H. Allen and Co., York-street, Lambeth, engineers and ironfounders, as far as regards R. Wright.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Adjudication.

W. E. Heavens (trading as W. Heavens and Co.), Hinton-street and New-street, Victoria Station, and residing at Fentiman-road, S.W., brassfounder.

Letters to the Editor.

*** *We do not hold ourselves responsible for opinions expressed by correspondents.*

*** *The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

*** *Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

AMERICAN AND BRITISH WORKMEN AND MACHINERY—BOUNCE v. PROGRESS.

To the Editor of The Mechanical World.

Sir,—I should not have thought it necessary to give any attention to the diatribe of "James Arthur," in the "American Machinist," had not some of your correspondents thought fit to notice the effusion, from which it may be assumed that there are other people in this country foolish enough to take an American at his own valuation. I would recommend anyone having an undue admiration of America and the Americans to read in "Martin Chuzzlewit" the description of a journey made in that country by the keen observer Charles Dickens, when probably he will see that all is not gold that glitters, and that the people of this country, in all points for which life is worth living, have an immense advantage. For although to those who have not visited the States this description may appear a caricature, to those who have made the journey it is not so, but is simply an accentuated account of events which took place then, and which take place now, of which the paper by "James Arthur" is a standing proof. Articles of this nature can frequently be seen in the columns of English journals, and they do rather good than harm, keeping our conceit within reasonable bounds; but the American papers very, very rarely publish such plain speaking against themselves. Whatever appears there must be "almighty hot and almighty strong" in praise of that "great and happy country." These sentiments are daily repeated in the American press, in language a little more veiled, but not much, and still the American is so dull that he does not appreciate the delicate irony of the remarks. A stranger could not poke fun at them half as neatly. It is this want of honesty and common sense that keeps America in the background. It is senseless because it makes them look so foolish in the eyes of all the world, and because by this means they are not acquainted with the improvements taking place in other countries. "The best of it is," said Mark Tapley, "that when they do happen to make a good stroke, such as better workmen with no such opportunities make every day of their lives and think nothing of, they begin to sing out so surprising loud"; and lest anyone should think that the days of such loud singing are past, I will give an extract taken from an American paper, and quoted in "The Paper-maker and British Paper Trade Journal" of September 30, 1892: "The Beloit Ironworks has been awarded by the American Paper-making Exhibit Company the contract to build the finest machine on earth, to be run at the World's Fair. The machine will be 106in. wide, and will be as perfect in detail as possible." Bless the American's little soul (for it must be little to write such stuff)! The Star Paper Company, Darwen, have a machine at present 147in. wide. This is larger than anything the Americans have been able to make, and has consequently given much umbrage there, the fact being perfectly well known in the States. Still it does not deter them from advertising their 106in. machine as being "the finest on earth," and the simple-minded folks round Chicago will believe it. Now and then an American visitor gets a little below the surface of laudatory inspired newspaper paragraphs and advertisements, such as Mr. Edward Marshall, of the Marshall Engine Co., U.S.A., who writes: "The English manufacturer is a party who knows his own business thoroughly, and attends to it faithfully, and is withal enterprising to a degree little understood by the average Yankee. He works behind closed doors and keeps his mouth shut, quite willing to be considered an old fogey so long as he gets the cream of the world's trade." This will partly explain why the English workman answered Mr. Arthur gruffly; like a wise man, he did not want to impart his experience to a nasal-twanged Yankee. Let him go and learn for himself, or pay a better man to show him. And to prove that there are better men here who are competent to show these things, please note that Messrs. Peter and Co., of Hollins, have recently lost four ordinary servants, who have become mill managers abroad, all of them, I believe, in the States, one of them being in full charge of the Spring Lane Mill, Pennsylvania. Before leaving paper-making I may just remark that a Lancashire firm, who made the 147in. machine above mentioned, wanted some large rolls for it, and were informed that an American firm could make anything in that line. The Yankees had, however, to admit their inability to make the rolls in question, whereupon the local firm, who make no pretensions, constructed them themselves. This is a correct specimen of American and English practice, "bounce *versus* progress." A firm in this city sent out a man not long ago to Johnstown, Pa.; out there he got £6, here he got £1 per week (not because work was slack, but simply because the work here was ordinary work, though impossible to the average American). This is why the Americans invent machinery to do that which in England is better done by hand; so when it *must* be done by the man, they apply to us to fill the deficiency. And this proves again how they are behind the times, for the man in question would not have been allowed to enter the country had the authorities known that he was under contract, by which they prevent themselves from rising to the English level. Truly their laws are worthy of the dark ages rather than of the nineteenth century.

Mr. Arthur has, singularly, not mentioned electricity, on which the Americans generally pride themselves, coupling with it the name of "the great and only Edison," as they vulgarly describe him. Is it because he saw a few things here which surprised him? In this, as in other things, they have been living in a fool's paradise, from which it has been left for us to drive them. In the "Engineer and Iron Trades Advertiser" of December 8, 1892, is a report of the meeting of the Philosophical Society of Glasgow, at which Mr. Mavor said he "was specially interested in seeing the large voltmeter, inasmuch as he was the humble means of persuading Edison's representative that in this country we were not behind America in electrical apparatus. When in America some two years ago he saw that the Edison Company were working in a very crude manner, while they imagined they were leading the world in electrical inventions. So thoroughly satisfied was the representative of that company with what he had seen on the Continent and in this country, that he had gone back and reorganised the whole system of electrical engineering on the lines adopted here, and had abolished the method on which he was working previously." The voltmeter referred to was the "largest in the world" (truly this time), made in Glasgow for the Edison Company of New York, the same firm having in hand a 30,000-ampère meter for the Brooklyn station of the same company.

Mr. Arthur speaks of cut wheels. Seeing that there are always three or four advertisements in The Mechanical World of wheel cutters, it cannot be said to be unknown here; but Mr. A. is like the lawyer in the trial who, against one witness who saw the prisoner commit the crime, brought five forward who did not see him do it. American-like, he did not see them, and, therefore, they did not exist. Perhaps he would like an English engineer's opinion as to why cast wheels are not received with favour in the States. Simply because they cannot satisfactorily cast them—an ordinary operation in an ordinary English foundry. There may be, and probably is, more noise in an English works than in one in the United States, because there is more work being done, but although there is more noise inside, there will be far less outside. And, speaking of wheels, I recently saw in the "Tramway World" a woodcut of "the largest wheel on earth" (what, again?), of course made in America. A draughtsman to whom I showed it fairly laughed at the fossilised manner of construction, which has been discarded here for over 20 years. If I were an American I should point out where the old fashion came in; but, being English, I keep my own counsel, and let anyone find out the difference who may be able. I also made some inquiries about milling machines, thinking there must be something in them, but was told by the sub-manager of a large works near Manchester that they had one, but compared with their ordinary tools it was a mere plaything, only doing about one-fourth the work. This is the real meaning of Mr. Arthur's remarks, that the tools he saw here were larger and finer than anything he had been accustomed to see, and instead of frittering round the forging they cut fairly into it, which surprised and annoyed him. If American engineering is so superior to our own, how does it happen that Messrs. Hicks, Hargreaves and Co. Limited are now making for Mr. Carnegie's own works (not quite, but very nearly) the largest steam engine on earth, with a flywheel of 90 tons? And not long ago Messrs. Galloways Limited sent a large pair over there. In this case the representative had time to come here and order the engine, which was made and delivered 4000 miles in a month less time than any American firm could even *promise* it. Why are their workmen "protected"? Are the weak or the strong protected? In England it is the women and children, not the full-grown men.

Mr. Arthur's article teems with misstatements. For example, he asserts that the English locomotive is "a wonderful little machine for drawing railway carriages, but when brought to America it is practically useless," etc., etc. How is that for high, and then how is it for truth? This has been discussed in England before, and in the "Engineer," of December 9, 1892, the mis-statement has been exposed thus:—"It will surprise him (a certain writer) to learn that the work done on the Great Northern road is very much in excess of that on the American road. The engines and tenders working the latter will weigh 90 tons, and haul a train weighing 143 tons; but the Great Northern engine and tender weighs 85 tons, and haul in summer trains weighing 240 tons. The lightest express trains on the Great Northern weigh almost as much as the heaviest on the American road. In the night express of the 2nd November the first portion consisted of 16 coaches, weighing 240 tons, or 100 tons more than the Empire State Express. We have no reason to doubt that the Brighton Company possesses plenty of locomotives which can haul 375 tons at 37 miles an hour." Thus are the American bubbles pricked with the simple pin of truth. When the Iron and Steel Institute was in the States a statement was widely promulgated that the American railways had doubled their receipts, whilst the English had only advanced 19 per cent., a convincing proof (?) of the superiority of their management. Sir Lowthian Bell quickly disposed of that argument by showing that, although the receipts had undoubtedly doubled, the miles of rails had also doubled, so that there was no advance in the actual condition of the railways. Yet the American papers will repeat the statement, and will once more show that they are "spry" and "smart." It is perhaps true that, although our locomotives are more suitable for our roads, they are not as suitable for the American way, which is accounted for by the fact that the roads here are substantially built and level, while in the States they are too frequently, to use the words of an American writer, "two streaks of rust and the right of way," In a journal published a few months ago, to "boom" Duluth at the expense of Chicago, I saw particulars of the officials of one of their railways, several of whom were English—a large proportion for the total number of Englishmen over there. Is not this a strong proof of the superiority of English training? We are continually sending them first-class men, and shall continue to do so as long as they and we are nations, and with the men we shall send them the latest information. In fact, when we fail to export men there, according to ethnologists, the American will retrograde to the type of the aborigines.

Mr. Arthur remarks that our point is "strength, strength, strength"; exactly, his light gimcrack machines would soon be consigned to the scrap heap, as the English engineer cannot afford to have such things about the place. I recollect a case of a firm near Manchester sending a particularly large engine to a works at Sheffield, where the owner was accustomed to say, "That engine is one of the secrets of my success, as with it I am never short of power"—an application of the principle of Napoleon that "the man who has reserves wins the battle."

Another assertion is: "The easy-going swing in British works is quite noticeable as compared with the greater activity and push in the American." This is comprehensible and is quite true, for our workmen make their money easier than the American. There is not the same necessity for insane strife, each workman endeavouring to thrust his fellow back in the fierce struggle. Sir Lowthian Bell, in his report last year, states:—"After what has been declared by the latest and most prominent advocate of Protection in the United States respecting the pay of American workmen, we are scarcely prepared to find, from documents compiled by State officials, on an inspection of the trading books of the miners and manufacturers, that the wages paid in Great Britain and in the United States approximate each other so closely"; and again, "This leaves a balance in favour of the United States workman of £7·25." We should have imagined about £107·25. to hear the American talk. One of our coal journals has just published the list of colliers' earnings, which shows very similar results. And when we find, as quoted in Ryland's iron trade circular this week, that here Glengarnock pig is 49s., Coltness 55s., and Shotts 53s., while in the United States the same brands are 78s., 84s., and 84s. respectively, we cease to wonder that American ironmasters have so many millions, which the poor devils of workmen have (I repeat, *have*) to grind out for them without being able to help themselves. Is it a wonder that the masters there are Protectionists, and pay large sums to perpetuate this fraud, and can we have a high opinion of the intellect of the Yankee workmen who allow themselves to be gulled, taxed, and then kicked by the employers?

Mr. Arthur speaks of the British having swarms of fitters. Precisely; we make a very superior article to anything the American turn out, and say nothing about it. One of their "scientific" writers a short time ago stated that there they put the valve faces together rough, and let them grind true, a mode of procedure which here would receive the well-merited "sack" if attempted. Long may our workmen be slow in adopting such improvements.

But the prime tit-bit is when Mr. Arthur talks about shipbuilding and "compares" the two nations. Read the following from the "Glasgow Herald":—Tonnage built this year—Great Britain, 982,202 tons; the States, 8078 tons. Steam tonnage in freight this year—Great Britain, 4,159,003 tons; the States, 357,269 tons; many of the Americans being made in English yards. Is not this comparing the pigmy with the

giant? We are now building two large ships for America on the Clyde, and the yacht of Vanderbilt is being made by Laird's. Moreover, they have passed an Act that none but American-built vessels shall be engaged in the local trade, and have subsidised a line between that country and England. This is a fair sample of a Yankee's argument. As a friend of mine told me recently, "If you get an American's catalogue, and it claims a strong point, beware—that will be the weak one!" and Mr. Arthur furnishes the proof. The American "Engineering News" assumes the same proposition, that they can turn out vessels at our cost or less, and then in the same article doubts its own words by saying that "it is a very different thing making a protected navy and building vessels for open competition." Our hardy trade is not protected, so they are quite at liberty to come and try. But they dare not give us the same privilege, for they know that probably not a vessel would be made in America in 12 months after the experiment, thanks to their protection.

Another statement is that boys from farms have introduced some of the best improvements. Surely Mr. Arthur can read, in which case he will find the names of Fairbairn, Telford, Stephenson, Murdoch, and others who rose from somewhat similar beginnings. But this occurred in the old days, when engineering was in its infancy, from which it is only fair to assume that in engineering matters the States are now where we were then, which, as they feel compelled to protect their manufactures, seems to be the case.

There is evidently a great difference between the English and American workman, for which we humbly thank heaven. In all civilised countries a man has his place: he is not compelled to remain there. Colonel North may be poor one day and a millionaire next; but let him act according to his station. If he is the principal, to speak civilly to his workman; and if he is the workman, to speak civilly to his employer. There is nothing to be ashamed of in honest labour—at any rate, not to an Englishman; though to the American there is, evidently. And what an enraging and ridiculous position to be placed in—to be compelled to follow an occupation and all the while to be ashamed of it, and "knowingly" anxious to leave. Still, when he reflects that his master is piling millions up at his expense, it is not to be wondered at. The aggressiveness of all Americans is most remarkable. When travelling in Europe they drop this peculiarity, and conduct themselves well; but as soon as their feet are on their native heath again they become insolent alike to inferiors, equals, and superiors. The very language of the ordinary people (if there are ordinary people in America) is an insult to a well-educated man. A servant of the hotel is asked to be kind enough to show you to your room; he does not condescend to reply, but talks on whatever subject he pleases, how long he pleases, and does his duty when he pleases. You ask a policeman in the street politely to show you the way; no answer, until you have satisfied him upon some point which it is an impertinence to ask. At first the stranger imagines he must have changed his habit and given offence somehow, but when he finds all treated alike he consoles himself with the remembrance of "home, sweet home." Many Americans feel this; the two largest ironmasters of that country live here; and so would the greater part of them if they could do so. What Dickens calls "the natural politeness of a savage" seems to require introducing, but they appear to have effectually "protected" themselves even against it.

There are a number of other platitudes in the article, which do not require serious attention: for example, the beautiful sentence, "the recognition of the individual," is already answered by the riots at the Homestead works, where men have been shot down and poisoned in the most primitive manner. And Mr. Arthur's "uncommonly bright woman" and "well-informed man" is an example of a joke which is now entirely played out by *our* humourists. It generally appeared in a form like this: "Your conduct is most noble," said Mr. Pickwick. "You are, I perceive, a man of sense and talent," replied Mr. Pott. And as a final commentary on the continual bounce which appears to be a disease with Americans, probably the following extract will be instructive reading. It is from an American paper in answer to a contemporary:—"This is a glorious country! It has longer rivers and more of them, and they are muddier and deeper, and run faster, and rise higher, and make more noise, and fall lower, and do more damage than anybody else's rivers. It has more lakes, and they are bigger, deeper, and clearer, and wetter than those of any other country. Our railcars are bigger, and run faster, and pitch off the track oftener, and kill more people than all other railcars in this and every other country. Our steamboats carry bigger loads, are longer and broader, burst their boilers oftener, and send up their passengers higher, and the captains swear harder than steamboat captains in any other country."

Let not the British working-man be deceived. The products of the whole earth come to Great Britain. The whole world is placed under contribution to provide for it, and with Free Trade there is no bar to any necessity. The working-man does not get all he wants—often not all he requires; but examination will prove that he is in a better position than are the workmen of any other country, even "God Almighty's free United States." A foreign statistician has just published figures showing that in England the days worked are 278, and in the United States 306, while undoubtedly the hours worked here are also much shorter. One of the Iron and Steel Institute members met a young draughtsman who had gone out from an ordinary engineering establishment here to a responsible position in perhaps the best firm in the States, to give them the benefit of his experience. Here he worked 46 hours, there he worked 60, and, as he expressed it, he *worked*, and fully earned his money. And yet, as Sir Lowthian Bell has shown, wages are practically the same, while the cost of articles in England is much lower, and in any case they are as cheap as it is possible to get them. Political freedom is practically perfect here; as Whitaker's almanac puts it: "The material greatness of the country is amazing. Its moral greatness is equal to the material. And although susceptible of much improvement, the British Empire under its present sovereign presents the nearest approach to a true commonwealth that the world has yet seen." The same cannot be said of America, where the rich men spend untold wealth to influence elections in order that the men may enslave themselves. As an example of this I may mention the M'Kinley tariff, which the masters (for they *are* masters, not employers, as in England) passed for their own selfish ends, and then persuade their gullible countrymen that they have established an industry in tinplates. Now, what are the facts. The American Tinplate Consumers' Association have issued a report from which the following are extracts:—"If we credit the American manufacturers of tinplates with the production of all that they have persuaded the special agent of the Treasury that they will make during the ensuing year, the result will be a total production in about three years of only 5 per cent. of the tinplates consumed by the country after the passage of the M'Kinley Bill, and to produce that 5 per cent. the extra cost to the country owing to the duties will have amounted to over 30,000,000dols., after making full allowance for rebates. Unless the American product should eventually amount to the greater part of our consumption, the cost of this unwise experiment will continue to increase at the rate of over 10,000,000dols. a year, and we are deprived of the prospect of relief by the arbitrary ruling of the Treasury, which includes as tinplates produced in the United States a product that is not an American product, and is not produced here. This rule allows American manufacturers to include in their returns imported steel (imported already for tinning), which they simply dip in America. When the M'Kinley duty was passed, no one had the slightest expectation that it would result in the establishment merely of the industry of dipping imported steel sheets, for this would give employment to about 1200 hands, whereas it was claimed that the tinplate industry to be established would give employment to 24,000 hands." Thus, to give employment to 1200 hands costs £2,000,000 per annum! Is it not correct to say that the American workman is easily gulled? Such a state of things would be impossible (I repeat impossible) here. Verily they want sending to one of our elementary political schools—for this is the Egyptian darkness in which we were passing an existence 50 years ago—so much are they behind us. I could go on exposing Yankee fallacies for another half-a-dozen columns, but I will just mention two things. First, trade has its rises and depressions; it is depressed now, but do not imagine that this state of things exists here only. In "Engineering" of a fortnight ago appears the following:—"The condition of affairs at the Homestead works seems to be more and more deplorable. A large number are out of work, and much distress prevails, and, to make matters worse, reductions in wages are being enforced, while some departments are practically closed. These are not the only works in the United States where things are bad from a labour point of view, in so far as the iron and steel industries are concerned. The Illinois Steelworks, employing 3500, are to close on the 15th inst. In Philadelphia reductions in wages are taking place. At Beaver Falls wages are to be reduced 20 per cent., so that in America the iron and steel trades are in a worse condition than in England." Secondly, contrast the Homestead strike with the Oldham cotton strike. On the one hand, 20 per cent. reduction, armed men brought illegally to shoot down the unhappy workmen, who in their turn shot down the law breakers, which the law seems powerless to touch; prolonged riots, accusations of poisoning, and counter accusations. On the other hand, 5 per cent. reduction, perfect order, not an illegal act performed, but all waiting for the peaceful solution, which is sure to come. Then ask which is the civilised country.

Finally, the Yankee is a thoroughly oppressed and down-trodden creature—politically, commercially, and socially. Politically, by the rings, caucuses, and Irish; commercially, by the Jay Goulds, Vanderbilts, combines, syndicates, and Carnegies, and he cannot help himself until he gets equal freedom and political education with ourselves. And socially by the women, who appear to look upon a man as a money spinner. We have a proverb here that "the man who pays the piper has a right to choose the tune;" but there is nothing more instructive than to go to an American dinner and see the poor men waiting patiently while the women and their male friends take the choice places.

We English have many faults, though, unlike the Yankee, we admit them and try to eradicate them, but when we consider our history, our power, and what we have done for the world in general, each of us ought, first of all things, to take a pride in being AN ENGLISHMAN.

Manchester, Dec. 26, 1892.

Miscellaneous Items.

The gross cost of all the railway lines in New Zealand, opened and unopened, up to the 31st of last March is £15,497,783.

There is no city in the world that keeps such accurate records of the entry of food and fuel supplies within its borders as Paris. This is due to the fact that a high import duty is levied on almost every article of domestic use which is brought to the city. During 1891 the total amount of coal consumed in Paris was 3,279,000 gross tons, of which 1,512,000 gross tons were brought to the city by river and canal; 1,767,000 gross tons were of French origin, 647,700 gross tons came from Belgium, 418,500 from England and 129,900 from Germany. The small amount of charcoal used as fuel in Paris will bring the total consumption of fuel to 3½ million gross tons. The yearly consumption of coal in London is 12 million tons.

The wreck is just reported of a vessel which, if not actually the oldest vessel afloat, is, or was at anyrate, a long way beyond a centenarian. The vessel was the Jersey barque "Eliza," and was built 120 years ago. She appeared in the register long before steamships came into existence, and for some time ran between Plymouth and Halifax, Nova Scotia, as a packet ship. After a time the "Eliza" had to fall out of the front rank, and subsequently was relegated to the timber trade. In this she remained a carrier for many years, and became a well-known vessel in the trade. From this she went into the fish-carrying trade between Newfoundland and the Brazils, and here ended her career. The "Eliza," in ballast, was leaving the Brazilian coast for Gaspe, Canada, to load fish, when she got ashore, and became a wreck.

Colonel Nicholas Potchinsky is engaged upon the completion of a nautical invention which, it is said, if eventually successful in practice will prove of incalculable benefit both to maritime science generally and in the saving of vessels from grounding in shallow waters or running upon unknown rocks. The apparatus provides means for automatically taking and indicating soundings for purposes of navigation, and is adaptable also for taking and indicating soundings for hydrographical, topographical, geological, and similar purposes. The invention, which is shortly to undergo a series of practical tests on a Russian vessel in the Black Sea, promises to be a conspicuous success, and as such must from a humanitarian point of view be an invaluable boon.

Daniel J. Galanaugh, the Philadelphia boat builder, is constructing the first eight-oared racing shell ever built from aluminium. It is intended for the use of the Cornell College crew, and will be finished towards the end of March. The boat will be 63ft. in length over all, 23in. beam amidships, 8⅞in. deep amidships, 6½in. deep forward, and 5½in. deep aft. The shell will be composed entirely of aluminium, with the exception of the wash-box, which will be of wood, and the outriggers, which are to be of steel tubing, cold drawn. The shell will weigh 175lb. all told. Ordinary paper and cedar shells weigh about 225lb. The aluminium shell will be built in two pieces, being divided fore and aft and then joined together amidships. It is designed to carry an average weight of 175lb. per man. The aluminium from which this shell is being made is one-twentieth of an inch thick and weighs about 7oz. to the square foot.

Many devices for effective lubrication have been tried for the various places where lubrication is necessary, and with varying degrees of satisfaction. The needs of diverse kinds of machinery, from a delicate high-speed engine to a rolling mill, are so manifold, in the kind of lubricant employed, and the method of its application, that it is well to examine into new methods advanced, to test their efficacy. While the lubricating bag is not by any means new, it has not, perhaps, been employed as widely as might be the case were its value more generally known and appreciated. The invention was patented in America, Great Britain, and Belgium in 1885, and was first manufactured by Mr. Theo. Phillips, at Middlesbrough. The lubricating bag is made of strong, coarse, porous material of any required shape and size, according to the position it is to occupy and the form of the neck or journal to be lubricated, and is filled with a special lubricant which varies in viscosity and melting point, and different textures of bag material are necessary according to the work to be done. The closed bag of grease is simply laid upon the journal and the requisite amount of lubrication is brought about automatically. The waste of material inseparable from the common method of applying the grease with a brush or swab is avoided, labour is minimised, and all risk of the journal firing from neglect is obviated, as the rise of temperature immediately causes a much more abundant flow of the lubricant.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

POOLE'S GRINDING MACHINE FOR LATHES.—Required, the address of makers of this machine,

FILTRATION.—Will any reader state the best method of filtering 150 gallons of canal water per day for steam-boiler purposes?—T. H. MITCHELL.

FRENCH AND ENGLISH WEIGHTS.—Can any reader inform me of a work converting tables of weights of millimetres into English pounds per metre run?—ANGLO-METRIC.

TWIST DRILL CUTTERS.—Can any reader give me a method of getting the correct thickness and shape of cutter for any diameter of twist drill, straight lip? A drawing will greatly oblige.—J. M. F.

"GRASS" PACKING.—Can any reader supply me with the address of manufacturers of this packing? I have seen it used for the piston and valve rods of L. and N.-W. railway engines.—LOCO.

GRINDING VALVES.—Will any reader advise me as to the best means of scouring brass valves and seats to a smooth face? I have tried flour emery, and a fast speed, but as I get at times different mixtures of metal in the valve and seat, I cannot smooth them both together.—W. THOMAS.

LOSSES IN STEEL FURNACES.—Could any reader kindly inform me the average per cent. of actual loss, and the average per cent. of skull, in the charge of a Siemens open-hearth steel furnace working charges of from 30 to 40 tons? And also the percentage of loss in heating slabs and ingots in the Siemens regenerative gas furnace?—J. R. R.

WINDING ENGINE.—What weight would a pair of 36in. cylinder engines by 4½ft. stroke raise from a pit with a spiral drum, commencing at 14ft. and finishing at 18ft. diameter, one side to wind from a depth of 350yds. and the other side from 400yds.; ropes to be 1⅛in. diameter, boiler pressure 80lb. per square inch, cut-off at ¾ stroke? What weight would the above engines raise from a depth of 280yds., with a flat rope drum, commencing at 12ft. diameter; sizes of ropes 5½in. by ⅝in. (steel)? What would be the rise in inches per yard of a slant whose angle is 26 degrees?—MINER.

SUGAR MILL ROLLS.—Will the writer of the article on sugar machinery or some other practical man say what is considered the best pitch angle and depth of grooves for front, top, and megass rolls, 30in. × 54in. second mill double crushing plant. What causes the juice to squirt out between top and megass rolls of the second mill? I have been told it is caused by hollow places; but in this case I am doubtful, as the rolls have no hollow places that I can see or feel by calipering. I think the distance between top roll and trash turner plate has something to do with the squirting, but opinions differ greatly.—SUGAR MILL (North Queensland).

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

B. FOSTER.—Have you tried hot water?

M. H. MAW.—We do not know of any such agency.

H. R. KERR.—We fail to perceive any striking novelty in your clinometer.

INQUIRER.—See our issue January 24, 1891, where you will find some particulars which may assist you.

TYRO. — Messrs. Bell's Asbestos Company Limited, 59½, Southwark-street, London, will supply you with the asbestos paints.

C. A. LEE.—"Gas and Petroleum Engines," by Robinson (14s.), is the only work we know likely to suit you. It may be had from our office.

SOUTH VIEW.—No satisfactory result can be obtained without an analysis of the water. Apply to Messrs. Sydney Minns and Co., Trafalgar-road, Dalston, London, N.

JOHN WELCH.—There is no special work on the subject, but you will find much useful information in Wilson's "Steam Boilers" (6s.), which may be had from our office.

SPARK.—(1.) Three cylinders are used in the Webb compound locomotive, two high-pressure being at the side in the usual way, and the third below the smokebox. (2.) The exhaust passes into the funnel.

HEATING FACTORIES BY AIR.—Can any reader inform me of any satisfactory system of heating a large factory by heated atmospheric air, and with what result? Also the address of the makers of the apparatus.—H. W. (Germany).——A.—The Sturtevant Blower Company, Queen Victoria-street, London, will doubtless assist you.

THREE-THROW PUMP.—A three throw single-acting pump has barrels 4½in. bore; 11in. stroke, runs at 25 revolutions per minute. It has 3in. delivery 35ft. high; suction pipe, 10ft. high; 230ft. horizontal length, with three bends. Would 3in. suction pipe be large enough to allow pumps to work to their full capacity?—F. C.——A.—The greatest speed at which water will flow through a suction pipe is 500ft. per minute, but in practice water should not flow at a greater speed than 200ft. per minute to ensure the pump barrel being properly filled. The 3in. suction pipe proposed would give a speed of water as follows:—Area of 4½in. plunger = 15·90sq. in. Speed of all three plungers in feet per min. = 87ft. Area of 3in. suction pipe = 7·07in. $\frac{87 \times 15 \cdot 90}{7 \cdot 07} =$ 195·7ft. per minute. Under the existing conditions, taking into account the 10ft. lift, length of suction pipe, friction due to bends, and the possible contraction of area due to substances deposited on the walls of the pipe, it would prove cheaper in the end to put down a 3½in. diameter suction pipe for these pumps.—ROBERT W. FIELDWICK.

BLUE PRINTING.—Can any reader kindly inform me what the necessary mixture for *extra rapid* ferro-prussiate sensitising fluid is made from, and the quantities?—FOUNDRY.——A.—Oxalic acid added to the ordinary blue print mixture materially lessens the time of exposure. The solutions used are:—(1.) Ammonia citrate of iron, 120 grains; water, 1 fluid ounce, to which add a few drops of strong ammonia solution till the odour is quite perceptible. (2.) Potassium ferricyanide, 105 grains; water, 1 fluid ounce. (3.) Saturated solution of oxalic acid. Equal quantities of the first two solutions are mixed together, and to 10 parts of this mixture 1 to 3 parts of the oxalic acid solution are added just before use, with the result that in cloudy weather the solution containing 3 parts of oxalic acid prints ten times as quickly as the pure solution. For ordinary purposes, however, it is better not to add more than 2 per cent. of the oxalic acid solution, or difficulty will be found in getting the lines white.—ROBERT W. FIELDWICK.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

16th December, 1892.

23,140 INDICATING BOLTS. E H Warden.
23,143 MACHINERY for CLEANING TIN and TERNE PLATES. W Williams and others.
23,149 APPARATUS for ENABLING a PASSENGER in a RAILWAY TRAIN to CALL the ATTENTION of the GUARD or DRIVER. W P Ingham.
23,150 MECHANISM for MECHANICALLY-PLAYED MUSICAL INSTRUMENTS. P. von Hertling.
23,153 FEATHERING SCREW PROPELLERS. H McIntyre.
23,155 METALLIC PACKING for the SPINDLES of CORLISS VALVES. S Drummond and T Abbott.
23,158 ELECTRICAL METERS. P E Singer.
23,159 ELECTRO-MECHANICAL DEPTH INDICATOR. A R G Beal.
23,162 PAPER BAG - MAKING MACHINES. R Mills.
23,163 MECHANISM for SCREW TAPPING.* A Cochrane.
23,166 CONNECTING of RAILS. R L Kirlew.
23,167 SCREW BOLTS.* D James.
23,168 APPLIANCE for SHARPENING the BLADES of SKATES. J Robertson.
23,169 DESULPHURISING IRON and STEEL. J Johnson. (*T S and T S Blair, jun.*, United States.)
23,172 MANDRELS. J M Smith.
23,173 PREVENTING IRREGULARITIES in the REGISTRATION of STATION WET GAS METERS. W Cowan.
23,176 FASTENING the ENDS of RAILS TOGETHER. H S Pitteway and W O Wood.
23,177 EARTHENWARE SANITARY PIPES. R Stanley.
23,178 SINGLE or COMPOUND DIRECT ROTARY HYDROSTATIC POWER MOTOR. H Masson.
23,182 GAS METERS.* H A Tobey and H T Yaryan.
23,184 SAUCERS for INDIAN INK. J P Maginnis.
23,185 ALARM CLOCKS and ELECTRIC SOUND SIGNALLING APPLIANCES. W Fielder and H Newmarch.
23,192 FIRE-PROOF FLOORS, ROOFS, ETC. J H Blakesley.
23,194 TREATMENT of TINNED IRON for the RECOVERY of the TIN. J C Butterfield.
23,200 HEATING FEED WATER. T Mudd.
23,201 TREATMENT of BLUESTONE and OTHER SULPHURISED ORES. J C Butterfield.
23,207 REGULATING the ADMISSION of STEAM to STEAM ENGINES. T Mudd.
23,208 SCREW PROPELLERS, VENTILATING FANS, and BORING TOOLS.* B Bernstein.
23,218 ELECTRIC MECHANISM for OPERATING VALVES. J Wagner.
23,219 ROCK DRILLS. E J Rule.
23,222 SIGNALLING APPARATUS for RAILWAYS. R Simmon.
23,224 COMPOUND FIRE BAR.* N Browne. (*A H Vater*, Germany.)
23,228 APPARATUS for or RELATING to the MANUFACTURE of ARMOUR PLATES.* A Longsdon. (*The Firm of F Krupp*, Germany).
23,231 AFFECTING in ELECTRIC GLOW LAMPS an AIR-TIGHT UNION BETWEEN ENTERING WIRES and the GLASS GLOBE. P Scharf.
23,232 SECONDARY or STORAGE BATTERIES.* J Y Johnson. (*A M Michel*, France.)
23,236 SMOKELESS COMBUSTION of FUEL. H H Lake. (*E Clarenbach*, Germany.)
23,237 STEAM BOILERS. E C Rusélle.
23,243 "COW-CATCHERS." L F Bernard.
23,245 APPARATUS for MEASURING FORCES and TIME and for ABSORBING SHOCKS. A A Guillot.
23,248 COALING SHIPS at SEA. P B Low.
23,250 NON-CONDUCTING COVERING for STEAM PIPES. B J Christie and others.

17th December, 1892.

23,268 EFFECTING RAPID and ECONOMICAL TRANSHIPMENT of COAL and COKE.* A W and J Robertson.
23,269 VARYING PRICE ELECTRIC SUPPLY METER. J Perry and others.
23,273 FIRE-GRATES and FURNACES for STEAM GENERATORS, ETC. J MacDonald.
23,275 VALVES for STEAM ENGINES. D N Bertram and G Thomson.
23,280 SIGNAL APPARATUS for RAILWAYS. J Armstrong and H Smith.
23,281 CONDENSERS. T Mudd.
23,282 SELF-CENTRING CHUCKS for LATHES. Francisco del Riego.
23,284 RAILWAY SIGNALS. E Barton and W Seddon.
23,286 STEEL or INGOT IRON. P M Justice. (*J Meyer, Directeur de la Société Anonyme des Hauts Fourneaux et Forges de Dudelange*, Grand Duchy of Luxemburg.)
23,290 ALTERNATE CURRENT MOTORS for SINGLE and POLYPHASE ELECTRIC CURRENTS. E Arnold.
23,291 FLUID METERS. E Bagge.
23,292 WIND WHEEL. E Brégier and J Normandin.
23,293 DOUBLE-ACTION PUMP. J C Tom and S B Hoover.
23,295 CENTRIFUGAL DEVICE for OPENING or CLOSING an ELECTRIC CIRCUIT. Sir D L Salomons, Bart.
23,299 APPARATUS for SEPARATING FINE COAL SLACK from IMPURITIES. A M Chambers and T Smith.
23,303 ATMOSPHERIC GAS BURNERS. J Slaytor.
23,309 APPARATUS for PRODUCING MOTIVE POWER. G H Jones.
23,312 ARMOUR PLATES. H H Lake.
23,313 COMPOUND for USE in the MANUFACTURE of ARMOUR PLATES. H H Lake.
23,314 AUTOMATIC ELECTRIC FIRE ALARUM. E F Cox.

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ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

(*With Index this Week*, TWOPENCE.)

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FRIDAY, JANUARY 13TH, 1893.

The "Umbria" Breakdown.

THE closing days of 1892 furnished an incident in marine engineering which will not soon be forgotten, and which is happily of a kind as rare as it is disconcerting. All the world knows now that the reason why the Cunard liner "Umbria" was nearly seven days overdue in her last westward voyage was due to the failure of her crank-shaft. As to the precise manner in which the fracture occurred, or its exact location, practically nothing is known, while the method employed by the chief engineer in temporarily repairing the shaft is also a matter of speculation. From one account it would appear that the failure took place some 12ft. from the engines; but another, and, we think, the more reasonable statement, is that the fracture occurred in the thrust-shaft. With absolutely no data to hand, it is, of course, impossible to comment upon the occurrence, and we are therefore the more surprised to find a leading London daily treating its readers to a most graphic account of the breakdown—an account which to the initiated is as amusing as it is ridiculous. This metropolitan luminary—which, we may at once say, is the "Daily Telegraph"—considers that "to those not familiar with the lower regions of these great liners, it may be useful to explain that the propeller is turned by a long beam of iron or steel, which passes from the engine-room to the sternpost through a circular passage called the shaft-alley. There is just room for men to walk along this in single file, stooping their heads, and taking care that nothing catches in the rapidly-revolving shaft. They must have access to feed the bearings of it with oil, and especially those of the thrust-block. This latter is a contrivance to take the tremendous push of the sea off the machinery, which otherwise would be absolutely broken up by the impulse of the screw. To carry out such a job as patching the big steel beam in this confined space is naturally in the last degree toilsome. The 'Umbria's' engineers could only work two at a time in the dark, stifling hole. To make 5in. borings into metal thus with hand-drills, and afterwards to cut away the setting for a collar with cold chisels, the ship rolling and pitching all the while, and to get the shaft so well spliced, in spite of all, within three or four days, that the 'Umbria' could afterwards do nine knots, was a very admirable piece of marine engineer's work. But," says this audacious scribe, "it is not the case that such a feat has never been accomplished before. A steamer plying along the South American coast from San Francisco to the Chilian ports not long ago cracked her shaft in a worse place—that is to say, close to the thrust-block. It was a diagonal fracture, the broken parts overlapping and being in true contact. Her engineers—the ship being hove-to—built up a furnace round the fracture, and kept up such a good heat with charcoal and bellows that they succeeded in fusing the bulk of the bottom shaft into one, aided by surface hammering, and that ship also steamed into port safely." When such unmitigated rubbish is allowed to appear in print, it is plain that if the daily press cannot employ competent men to deal with technical subjects they had far better preserve a discreet silence upon such matters if they wish to avoid being made an object of ridicule.

Electrical Legislation in Germany.

IT is probable that the Electric Lighting Bill formulated nearly two years ago for the control of the electric-lighting industries in Germany, and to which reference has already been made in these columns, will be passed during the present session of the Bundesrath. Various unavoidable delays have occurred, but the Bill has now, after numerous alterations, passed through various committees. Most of the alterations refer to the laying underground or suspension overhead of electric cables and conductors generally, and the respective positions of electric-light companies and local and other authorities. The Bill is shortly to be under the consideration of the Plenum of the Bundesrath, and will, it is thought, be finally passed.

German Ironworks in China.

IT is reported that the negotiations which have for a long time been proceeding between the Viceroy, Li-Hung-Tschang, and the German firm of Krupp, of Essen, for the establishment of ironworks in China, have been brought to a satisfactory conclusion. According to this, Krupp will erect a foundry, rail-rolling mill, and other works, in Kaiping, where are situated the Tientsin coal mines. These new works would, it is said, be commissioned to supply the fixed and rolling stock for the projected railway from Tientsin to Shanghai-Kuan, and eventually to be extended to Kirin in the Mandschurei. A Rhenish-Westphalian paper, on the other hand, denies that there is any truth in the above statement, which has, however, not been contradicted by the Essen firm.

Ramie Fibre for Steam Pipes.

A STATEMENT has during the past year been travelling to and from the United States and this country concerning the use of ramie fibre for steam and other pipes, and several inquiries have been made as to the manufacturers of such pipes. We are, unfortunately, unable to impart this information; but the mention of an estate where ramie fibre is grown may be interesting, and may also lead to particulars of the pipes being obtained. Mr. R. R. Neill, of the United States Legation, furnishes the following particulars:—Ramie is grown on the estate of Señor Pinillos, of La Legna, near Lima, Peru, and is worked through a machine without any preparation. There are at present some 40 acres of ramie planted at the estate of La Legna, but this could be doubled in a very short time. The plant yields from four to five crops per annum, and 10 tons of clear fibre is calculated to be obtained annually from each acre, from £28 to £30 per ton having been offered for it. The machine in question was made at Lima by unskilled workmen, and Mr. Neill states that if proper machinery could be obtained better results would be secured. Mr. Norman Evans, an Englishman residing in Lima, is interested in the growing and manufacture of this valuable fibre plant; and it is possible, we venture to think, that either he or Señor Pinillos, as producers and sellers of ramie fibre, might be in a position to state the names of the makers of ramie fibre steam pipes.

Electric Lighting of Churches.

SOME time ago it was announced that the famous St. Stephen's Cathedral, in Vienna, had been equipped with the electric light. This was in October last; and instead of installing incandescent lamps, as has been the general rule in church illumination in this country, 12 large arc lamps were put up. The trial of the lighting was attended by the Cardinal Archbishop of Vienna, and the cathedral clergy, with the governor, the mayor, and town councillors, etc., who seemed satisfied with the installation. This had been fitted up by Messrs. Siemens and Halske; but the lighting was only continued for a few days. It now appears from a report of the church authorities that the electric light will not be introduced, those authorities having come to this decision on liturgical, æsthetic, and practical grounds, one of the so-called practical reasons being the danger of fire. Fortunately, no such reasons obtain in this country; but objections might, and would doubtless be made against the adoption of arc lamps instead of glow lamps.

Train Heating.

THAT considerable opportunity exists for effecting improvements in the method of heating railway carriages is, we think, altogether beyond question. To furnish the ancient and inconvenient foot warmer is on most lines the only attempt made to minister to the passengers' comfort in this direction, and all railway travellers will readily admit the inefficiency of this rude device for the purpose named. Recently a new system of train heating has been tried on one of the Scotch lines, which appears to have given good results. It consists of a shaft running down each end of the carriage and continuous with one running underneath the floor. From this horizontal shaft branch pipes admit the air into the various compartments, while through the shaft a steam pipe connected with the engine passes, and thus the air which the motion of the train propels through the shaft becomes heated, and in this condition passes into the compartments. The temperature at the orifice of these branch pipes reached 154°. The air within the compartment is distributed by means of a box, which is perforated in front of each passenger, and thus the air is disseminated equally throughout the compartment, the warmest portion of the carriage being that in proximity to the feet of the passengers. The results of the latest experiments showed that while the temperature of the outer air indicated 12° of frost, the carriages in which the apparatus was not used registered 30° F. The thermometer placed in a carriage where the apparatus was fitted registered 120° at the feet of the passengers, and when placed upon the rack indicated 43° F.

The Liverpool Overhead Railway.

ON Saturday last a trial trip was made on the Liverpool Overhead Railway, the construction of which was commenced in 1889. A full description of the railway has already appeared in THE MECHANICAL WORLD, and it will now be sufficient to note that the trial was in every way satisfactory, the freedom from vibration being specially noticeable. We may add that the Electrical Construction Corporation of Wolverhampton have put down the engines, boilers, electrical plant, conductors, signals, carriages, motors, and all switches and appliances, and take the full responsibility and expenses for their maintenance and running for two years for 3½d. per train mile. This charge covers depreciation, repairs, and staff expenses in connection with the plant, and it may be noted that only about thirty employés are required by the Overhead Railway Company for traffic arrangements, collection of fares, and other incidental requirements of the line. It is calculated that about 4H.P. hours will carry a train of two carriages one mile, and as each horse-power hour costs about 2lb. of coal, the value of 8lb. of coal deducted from 3½d. gives the margin allowed to the contractors for depreciation of plant and staff expenses. We understand that the line will be formally opened by Lord Salisbury on February 4.

Russian Petroleum in Asia.

WHAT the late Mr. C. Marvin so vividly described as the "regions of eternal fire," have lately been in a rather depressed condition; but endeavours are now being made to greatly extend the markets for Russian petroleum. So much so, that directly permission was recently given for the passage of tank steamers through the Suez Canal the Russian petroleum producers drew up a remarkable scheme for the establishment of a pipe line from Ensebi (near Rescht, on the Caspian Sea) right through Persia to the Persian Gulf, and from here the petroleum would be shipped to India, Australia, China, and Japan. The petroleum firms of Baku have formed a committee to work out the details of the project, which, if carried into execution, would, according to present estimates, considerably reduce the price of the oil and greatly increase its sale.

Care and Management of Patterns.

THE casual observer, who may visit the average foundry and observe the manner in which the patterns of their customers are used, would naturally think that they were never intended to be used again. To the practical mechanic, who understands the expense of constructing suitable patterns and keeping them in proper shape and repair, the reckless and careless manner in which they are handled in the foundry by the moulders is sufficient to account for the extra expense which their customers are subjected to in keeping them in proper condition for future use. With the best of care all wood patterns are subjected to unfavourable conditions from the time they leave the pattern-room until they are returned again to their proper place, and few will be found that have not received more or less injury. The warm damp sand into which they are embedded during the process of moulding is unfavourable under the best conditions, as it is impossible to so protect the surface as to entirely prevent it from absorbing more or less dampness, which always has a tendency to swell it and start the joints, no matter how well they may be constructed. Now, to a certain extent, especially with large patterns which sometimes are obliged to remain in the sand overnight, this is unavoidable; but the careless manner in which they are kept after being taken out of the sand often does them more damage than the process of moulding. It is no uncommon thing to find such patterns, after being used and before they are taken from the foundry, carelessly thrown upon a heap of damp sand and there remain for a whole day or more before they are removed to the pattern-room, and the joints, which have already absorbed sufficient dampness while being moulded, are further opened and distorted in consequence. It is probable that few machine shop proprietors ever know exactly what it costs them, or how much of the profits of the shop are absorbed in keeping their patterns in repair, for, as a rule, when a pattern requires repairs it is taken to the pattern-shop, and no separate account of the actual expense for repairs is kept. The pattern-shop is an institution that no machine shop of any size can do without, and the expense, whether for new patterns or repairs of old ones, finds its way into the expense account, and must eventually come out of the profits of the business. There is no excuse for much of the damage sustained by patterns while in the foundry. No matter how well they may be provided with plates for rapping

and drawing, the moulders will frequently drive a spike or screw a lifter into some vital part where it was never intended, and often the pattern is not only marred but split in consequence. The skilful pattern-maker will always know at what points to place those lifting plates, and the careful and experienced moulder will never insert a lifter at any other point. But with some it makes but little difference, no matter how much the pattern may be damaged in consequence. For this reason, whenever it is practical, all small patterns, and even those of moderate size, should be made of iron or brass where it is known that they will be much used; and although such patterns are necessarily more expensive than wood in the first instance, they will be found the cheapest in the end. But with large patterns, such as the frames of machinery or heavy gearing, the extra cost of constructing and the inconvenience in handling renders metal patterns for this purpose out of the question; besides, with the frames of most machines frequent alterations are necessary. While most of the damage sustained by wood patterns takes place in the foundry, yet much damage is often sustained from the want of proper care after being used. Every machine shop should have a pattern-room aside from the pattern-shop, and in as close proximity with it as practical, and when patterns are taken from the foundry, which should be as soon as possible after being used, they should be carefully examined by the pattern-maker, and any damage which they have sustained should be carefully repaired before they are put away for future use. The pattern-room should neither be too warm nor too dry, for patterns kept in a warm, dry room will often sustain more damage from warping and shrinkage than from proper use. In many of the smaller machine shops no especial provision is made for patterns, but they are often placed upon shelves in the shop, where they are exposed to the dry heat that is always found in such places, and valuable patterns, after remaining in such places piled on the top of each other a few weeks, are often found so badly warped and twisted that it requires much labour to restore them to their proper shape before they can be used; and that is not all: the same process is frequently necessary every time they are used. Now, there is no machine shop worthy of the name but can afford to partition off a corner in some place for this purpose, where patterns may be kept cool, and not be exposed to the dry heat of the shop, and the expense of providing a suitable place for this purpose will cost less than the damage and repairs.

Pattern-making is a branch of mechanics that requires much skill and care, and the construction of permanent patterns that will be in constant use cannot be too well performed. The lumber should be carefully selected and perfectly dry, and where several pieces are to be glued together, it should be as near uniform as possible, as it will not answer to use a hard and soft piece in the same block, as one is sure to shrink and swell more than the other, and the pattern will either warp or become distorted. Neither is it good practice in such cases to cross the grain at right angles, for the reason that all lumber will shrink more or less crosswise, while there is no shrinkage endwise to speak of. Consequently, the shrinkage being in opposite directions, the pieces will either warp or break the glue and pull apart, whereas if the lumber is so put together that the grain will cross at a small angle, the pattern will be just as strong and the shrinkage more uniform, with less liability of being distorted by the constant swelling and shrinking that all wood patterns are subject to. Again, the proper care of patterns, after being used and returned to the pattern-room, consists in not only repairing any injuries that they may have sustained in the foundry, but in so placing them upon the shelves that they will lie in a position favourable for retaining their shape. With large frames that cannot be kept upon shelves it is better to either hang them up where the air will have a free circulation upon all sides, at such points that, while they may lie in a position favourable for retaining their shape, the air may have a free circulation around them also; and while, as a rule, patterns receive less care and attention in the average machine shop than any other part of the outfit, yet there is no question but much of the incidental expenses which go to reduce the profits yearly might be saved by bestowing more care and attention to the patterns.—"Mechanical News."

The Corean Government is stated to have engaged several Russian mining engineers to inquire into the mineral resources of Corea.

The Under-type Stationary Engine.—XXII.

In the last article (page 222, vol. xii.) we gave a sectional drawing of a locomotive boiler, to which we must refer our readers as occasion requires.

The boiler shells are made of Siemens-Martin mild steel, with a tensile strength of from 27 to 30 tons per square inch of section, and an elongation of 25 to 32 per cent. in 8in. The circular seams are single riveted, and the longitudinal seams are double riveted, as per Fig. 37, with ⅝in. mild steel rivets. The fireboxes are of Lowmoor or Bowling iron; steel plates are sometimes used for fireboxes. Lap-welded iron tubes are mostly specified; they are swelled $\frac{1}{16}$in. larger diameter at the smokebox end for about 3in. up, so that they can be easily withdrawn for scaling or renewal. The washers between the firebox top and the underside of the girders are of cast iron 2in. deep.

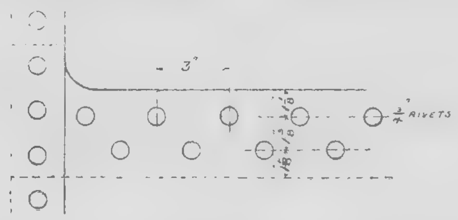


Fig. 37.

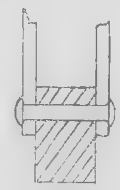


Fig. 41.

Figs. 35 and 36 show the firebox front and tube-plate stayed by means of a piece of strong section channel bar; this mode of staying these surfaces will only do for small boilers; we much prefer one or two bars of strong section T-iron. Failing that, Fig. 39 shows a good girder stay. In some boilers two such girders are used at the firebox end, while at the smokebox end there is room to introduce gusset stays. In the larger sizes of locomotive boilers gusset stays can be introduced at both ends of the boiler. Fig. 40 shows gusset stays at the firebox end of a large boiler; it will be seen that the centre gusset extends to the second plate, leaving ample room for one or two fixings on the arch plate; the remaining gussets are attached to the arch plate, as shown. It is sometimes necessary to use a girder stay like Fig. 39, in addition to three or more gusset stays. One roof bar is shown in Fig. 40 placed across the firebox, which allows more room for the gussets, and the wash-out plugs can be so conveniently disposed between the roof bars, as shown, that rakes can be applied for removing the sediment from the firebox top. It is important that the roof bars be placed at least 2in. above the firebox top, and the distance washers should present as little surface to the firebox plate as possible (see Fig 38). The roof-bar bolts are pitched about 5in. centres, and the undersides of the heads of the bolts are turned conical, and fit into holes drilled in the firebox crown; these bolts never leak, add grummets and similar makeshifts are dispensed with. The Belpaire type of locomotive boiler is an excellent one for large powers. It possesses numerous advantages, and the wonder is that it is not more often used.

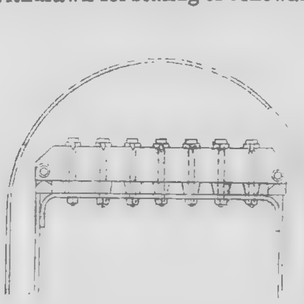


Fig. 38.

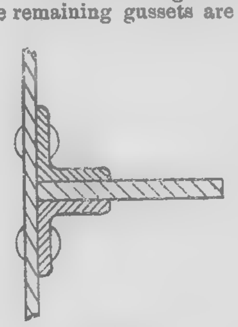


Fig. 39.

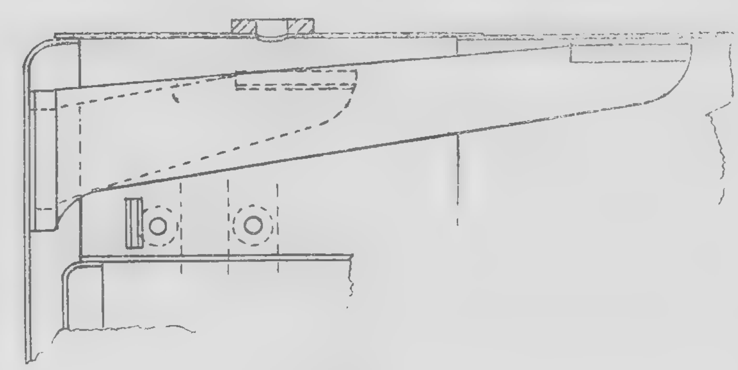
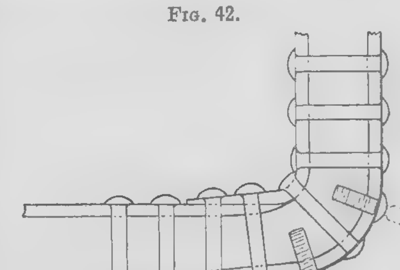


Fig. 40.

The front of the firebox and saddle plate is flanged by hydraulic pressure to a radius of 4in., the sides and top of the firebox and the firebox shell are formed of a single plate; the firebox side stays are pitched 4¼in. apart. In the sectional drawing of the boiler, it will be seen that the roof bars are placed longitudinally. The firebox roof stays are often placed transversely in large boilers, as they can be made of much lighter section, the width of the firebox being considerably less than the length of the box. When the roofing bars are placed crosswise, the sides of the firebox and the top are made of three plates, so that the roof bars can rest on the side plates. Fig. 38 shows an American type of roofing bar, where the sides of the firebox are carried up to form a flat bearing.

Fig. 42.



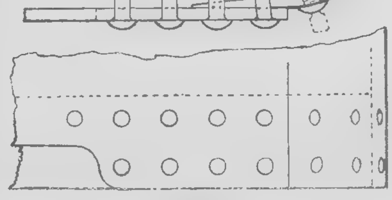


Fig. 43.

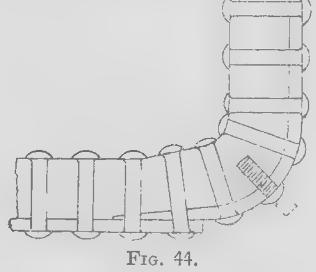


Fig. 44.

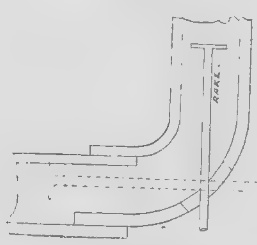


Fig. 45.

Solid iron firebox foundation and firedoor rings are now used by all good makers in preference to Z-iron frames. The water space around the firebox varies in width from 2½in. as a minimum, at the bottom, to 3 or 4in. at the top, thus giving a good circulation of the water where it is most needed. The firebox plates are dished around the firehole, as shown in Fig. 35, thus reducing the solid ring to less than 2in. thick, enabling the makers to produce a better job. In a previous article we referred to the enormous pressure which the firebox side stays and foundation frame are subjected to when the boiler is under steam. For instance, in a 20H.P. locomotive boiler the firebox top presents an area of 12·25sq. ft., and when the boiler is working at 100lb. pressure there is no less than 78 tons tending to force the firebox out of the shell, as under:—

$$\frac{12 \cdot 25 \times 144 \times 100}{2240} = 78 \text{ tons.}$$

Yet, notwithstanding these figures, we occasionally see large boilers made to work at 80lb. pressure having weak and unsatisfactory Z-iron frames, and ordinary roofing bars without any sling stays, to resist this enormous pressure.

The Z-iron frame answers very well for small portable boilers working up to 60lb. pressure; in some instances, however, a good deal of trouble is caused by corrosion of the frame at the corners. For all locomotive boilers of from 12 to 15H.P., inclusive, the solid foundation frame should always be used.

We now give illustrations of the solid frame, showing the method of construction. Fig. 41 shows a section of the solid frame some distance from the corner. Fig. 42 gives a sectional plan of one corner of the frame, showing the top row of rivets. Fig. 43 shows a side elevation, and Fig. 44 shows the bottom row of rivets. It will be seen that these figures represent the solid frame often adopted for large boilers, the corners of the outside firebox plates being double riveted; for smaller boilers the double riveting may be dispensed with. The drawings show the thinning of the plates and the arrangement of the rivets. In the top row of rivets we show two corner screws, and by a modified disposal of the rivets in the bottom row, only one screw is necessary. The solid frame must be made a good fit, and particular care must be taken with the corners. In boilers having the back and front firebox plates flanged to a large radius, the mudholes can be placed in the corners, as shown by Fig. 45. It will be seen that the rakes can be worked in both directions, and it is possible to see through the water space, as the mudholes are opposite each other. Some makers connect the saddle plates to the barrel by means of a double-riveted seam. In previous illustrations we have shown the style of wrought-iron ashpan usually adopted for the separate locomotive boiler. (See Article No. XI., in The Mechanical World for 19th February, 1892.) The stand at the smokebox end is mostly made of wrought iron. Large boilers are occasionally connected to brick chimneys, in which case the stand at the smokebox end gives place to a down-take, which may also be made of wrought iron and lined with firebricks; a damper door should also be supplied. This down flue connects the smokebox of the boiler with a culvert, through which the gases are conducted to the chimney. If the brick chimney is in front of the boiler, there should be room enough left between the smokebox door and the chimney to enable the tubes to be swept. If an iron chimney is adopted, and the exhaust steam from the engine is available for increasing the draught, the chimneys given in the table in Article XX. will be of sufficient area. If the exhaust steam cannot be turned into the chimney, and the boilers depend upon natural draught, the chimneys will require to be larger in diameter and the height increased in due proportion.

(To be continued.)

The Institution of Civil Engineers has now been established three-quarters of a century, having been founded on the 2nd of January, 1818, its object being the promotion of mechanical science, particularly in its application to civil engineering. There are at present on the books 5122 corporate members, of whom 1795 are members, 3312 associate members, and 15 honorary members, besides two other attached classes—namely, 389 associates and 830 students,—making a gross total of 6341, against 6131 at the same date last year.

Tests of Longitudinal Elasticity of Boiler Flues.*

The desire to obtain dry steam of high pressures, which has been felt to be a necessity for successful operation of triple-expansion and compound engines, has constantly increased the field for internally-fired flue boilers. Such boilers long ago superseded all others for marine purposes and are indispensable for portable boilers, while they have recently been introduced for locomotive engines with very satisfactory results, as in the Lentz system. Numerous vertical boilers are now built having internally-fired flues or corrugated furnaces, but these latter are of particularly frequent application in stationary boilers having one or two flues. By combining the flues with an overlying return flue, or by introducing Galloway tubes or the return tubular system, innumerable different designs have been produced, in all of which the main flues are the most important and sensitive parts, as they either serve as furnaces or are at least immediately adjoining the centre furnace or highest temperatures, and always receive the most careful attention in the designing department, as well as in the shop.

The flues are nowadays invariably of circular section; but different methods of stiffening them and of connecting the several sections with each other or with the boiler ends have produced a variety of forms now in common use. Inasmuch as these flues must not only be able to resist steam and water pressure, but must also be proof against all sorts of unequal strains produced by unequal expansion and contraction, due to different and varying temperatures at different points, it seemed of great interest and value to determine the exact behaviour of the different kinds of flues in the market by actual tests; these tests were to determine the resistance to temperature changes of these flues.

Taking the case of an internally-fired flue boiler of about 32ft. length and 78in. diameter, whether single or double-flue construction, we shall find by actual measurement a furnace temperature of about 2460° F. over the grate, while at the back end of the flues it falls to 1200° F., and the gases passing over the shell have a temperature of but 570° F. Neglecting the influence of unequal temperatures in the water during the period of raising steam, and supposing that when in operation they remain practically uniform, ensured by proper circulation of the water, it is nevertheless undoubtedly true that different parts of the boiler are subjected to different temperatures due to differences of temperatures in the surrounding furnace gases. It is self-evident that the temperature of the flues must be higher than that of the shell.

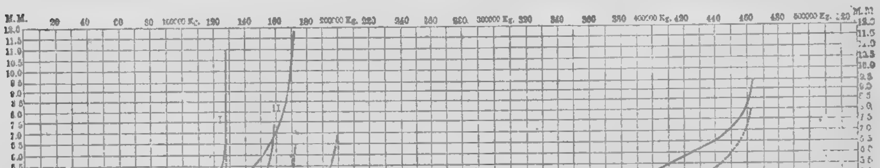


Fig. 7.—Plotted Tests of Longitudinal Elasticity of Boiler Flues.—Nos. I, II, III, IV, V, Corrugated Flues.—No. VI, Adamson Flue.—No. VII.—Purves Flue.

Fig 8.

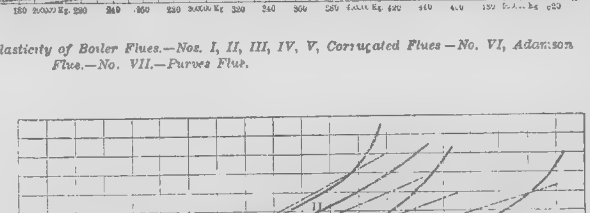


Fig. 9.

As far as the author is aware, no direct experiments have as yet been made to determine these differences, but their existence is demonstrated by experience, as in all boilers in which the flues are not flexible and are connected to stiff end plates, it is well known to experts that leakage invariably occurs at the points of connection as soon as put in service. In fact, the amount of swelling or buckling of the ends, when free to move, near the connection with the flues, is a good measure by which to determine the differences of temperature existing between the shell and flues. On the basis of such practical observations of unstayed ends, it has been calculated that there is a difference of 105° F. between the temperatures of flues and shell in the boiler above described. Assuming this difference of temperature, we find it would produce an expansion or elongation of 0·2in. in a flue 32ft. long when the coefficient of expansion is 0·00124. As the ends are firmly stayed and rigidly connected to the shell as well as the flues, this difference in expansion must produce abnormal strains in one or many places or parts, which can only be taken care of by distortion of the boiler. A very small part of the strains is transmitted to the shell, which is elongated slightly under their influence. The greater part, however, produces elongation of the boiler ends and stays, or excessive compression of the flues, which may produce bulging or buckling. In all boilers having flues which are practically incompressible—or, at least, offer considerable resistance—proper provision must be made in the staying to permit distortion of the ends.

We have, however, at the present time hardly the crudest empirical formulæ by which the elastic resistances of flat surfaces can be determined, and they are not reliable, especially for high steam pressures. That this fact has become generally accepted is demonstrated by the action of a number of large manufacturers, who have found the means sufficient to make exhaustive experimental investigations of the subject, which have been assigned to Professor Bach, of Stuttgart. It remains to be seen whether these investigations will supply the desired knowledge, but it must in any case be desirable to boiler makers to avoid this difficult construction by substituting flexible flues, and thereby avoiding all trouble.

Proper staying of boiler ends to not only resist the steam pressures, but at the same time to provide for the changes of the flues, is indeed a very difficult problem, as very slight deficiency or excess may produce the most deplorable results. When, however, the flues have longitudinal flexibility, the boiler ends may easily be stayed so thoroughly that leakage is entirely avoided, and be strong enough to resist all strains due to elongation of flues without distortion.

When the shell receives no part of the heat, as is the case in locomotive boilers, then it becomes plain that the relative expansion becomes very much greater, as the difference in temperatures rises to 1200 − 375 = 825° F., instead of 105°, as above. In the case of marine boilers, it is exceedingly difficult to determine to what extent the flues may act as stays, on account of the complexity of construction and the great variations of temperature in adjoining parts. There are considerable variations in the temperatures of the furnace flue. The smokebox has still a different temperature, and the back end, or diaphragm, is subjected to great variations between the highest and mean flue temperatures. All of these parts are constantly working, and here faulty construction will immediately produce leakage at the return flue joints upon raising steam. To avoid this, the ends and crown plate are sufficiently well braced to resist all strains, neglecting the bracing effect of the furnace flues entirely, and giving the latter ample longitudinal flexibility to allow for any possible elongation or strains, thus avoiding leaky joints altogether.

Although the above discussion demonstrated the demands made upon the longitudinal flexibility of flues, no facts or results of tests have heretofore existed which could serve the practical boiler maker as a guide. Therefore a series of full-size tests of boiler flues were made at the Essen works during last spring in the presence of a number of State officials and engineers, to determine the longitudinal elasticity and flexibility of different forms of flues. The tests were all made in precisely the same manner, and the results plotted in curves for purposes of comparison. The method adopted was to compress the flues to be tested in a hydraulic plunger press of 64in. diameter, by placing them between the fixed end and the plunger after having turned off their ends truly parallel and at right angles to their axis, the stress being applied parallel to the axis. In this press a pressure of one atmosphere would produce a load of 47,500lb. when the stuffing-box friction is neglected.

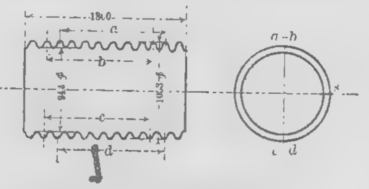


Fig. 1.—Corrugated Flue, No. IV

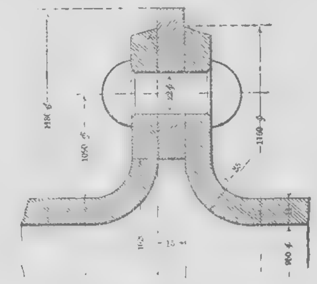


Fig. 4.—Adamson Flue

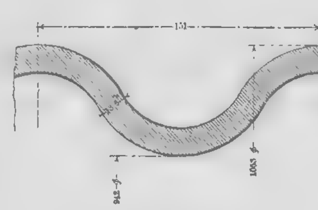


Fig. 2.—Section of Corruga...

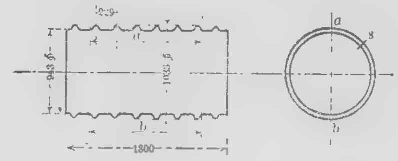


Fig. 5.—Purves Flue, No. VII

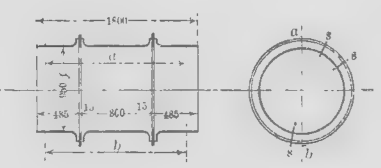


Fig. 3.—Adamson Flue, No. VI.

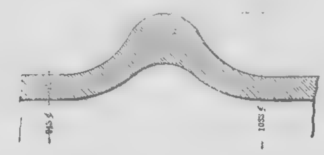


Fig. 6.—Section Purves Flue.

Seven flues were thus tested—five of which were corrugated, of different thickness of metal; one was a cylindrical flue with Adamson flanges, which were 13½in. apart; and finally a ribbed Purves flue. The six former were made at the works of the Schulz Knaudt Company, while the latter was brought from John Brown and Co. Limited, of Sheffield. The flues were all about 71in. long. From two to four places were selected on the different flues for purposes of measurement, on which centre-punch marks were made about 48in. apart; steel bar compasses were used for taking measurements, provided with wooden handles to avoid error due to expansion produced by the warmth of the hands.

No. of Flue.	Style.	Plate, Thickness in in.	Weight in lb.	Tenacity in lb. per sq. in.	Elongation, % in 8in.	Maximum Working Pressures. Hamburg Standard.	Maximum Working Pressures. British Lloyd's	Depth of Corrugations in in.	Compression of Flue in % under 220,480lb. load.	Load required to Produce Compression of 1-1000 of Length in lb.	Elastic Limit passed at Compression of % of Length.
I.	Corrugated ..	0·399	1140	52,900	25·0	135	105	1·93	6·375	59,520	0·39
II.	" ..	0·462	1257	66,000	28·5	159	160	2·09	0·33	63,920	0·419
III. ...	" ..	0·474	1330	47,360	30·0	166	135	2·02	0·26	79,380	0·336
IV. ...	" ..	0·537	1598	49,490	29·5	190	159	2·19	0·21	108,040	0·32
V.	" ..	0·399	1085	54,720	26·0	129	—	1·18	0·095	238,130	0·19
VI. ...	Adamson	0·553	1764	51,320	29·5	129	163	—	0·06	374,820	0·084
VII. .	Purves	0·474	1576	60,830	26·0	166	159	—	0·02	771,730	0·158

In the case of the corrugated flues the four measuring places were selected on alternate corrugations, as indicated in the figures by letters *a b c d* (Figs. 1 to 6), while the location of the welds is indicated by the letter *s*. The pressure exerted by the press was measured by two gauges, one of which was a carefully-calibrated standard gauge. After placing the flues in position in the press, the distance between centre-punch marks was again verified by the beam compasses and before any pressure had been applied; thereupon a pressure of one atmosphere per square inch (14·7lb.) was applied, and the contraction indicated by holding one point of the compasses in the punch mark, while a scribe mark was made on the flue with the other, on a surface which had been previously prepared for the purpose. The distance between the scribed line and the punch mark was the amount of compression, as the pressure was maintained at a constant point by opening the admission valve enough to make up for the leakage. After thus measuring the contraction at all points previously prepared, the pressure was entirely released and the flues were then examined to determine whether any permanent set had been produced. Having completed these measurements, the pressure was again applied, but raised one atmosphere, and this was continued until the flues would no longer carry the pressure applied or until the capacity of the press was reached, at 25 atmospheres. In many cases the same loads were repeated several times, or carried for a longer period, and it was found that elastic resistances were uniform or constant, and such repeated tests did not produce permanent set when none had been produced by the first application of the load.

The mean of each of these sets of measurements was then reduced to a standard basis of measurements of 39⅜in. (1000mm.) and plotted on the diagram, as shown in Fig. 7, and marked I. to VII., and in which the full lines give curves of measurements of compression under loads, while the dotted lines show curves of permanent set. These curves are obtained by plotting the percentage of longitudinal compressions as ordinates, and the actual loads applied by the press as abscissæ.

The great difference in these curves is most striking, and shows the relative longitudinal flexibility and rigidity in a most remarkable degree. As was to be expected, the corrugated flues I. to IV. are the most flexible, and in proportion to thickness of metal, while flue No. V., which has more shallow corrugations, although made of much thinner metal (0·4in.), is nevertheless considerably stiffer. Following this one in stiffness is the Adamson flue (No. VI.), and the least flexibility is shown by the Purves flue (No. VII.), which could not be crushed, as the hydraulic press lacked sufficient power.

In the table above is given all the necessary information about the different flues, showing their differences in every particular, the weights, working pressures as deduced from Lloyd's, as well as from the Hamburg standards. The tensile strength of the material used was

* Abstract of a paper by Mr. Knaudt, read before the German Society of Mechanical Engineers.

obtained from strips cut off the plates before bending, and observations made on the 8in. (200mm.) standard length. In the case of the Purves flue (No. VII.), ordered for the purpose, a strip was cut from the end, straightened, and then tested in the same manner and machine as the others. The flues had practically the same diameter of about 37in. in each case, and therefore served admirably for making comparisons, when taking into account their allowable working pressures. In the foregoing table will be found the measured compressibility of the different flues under a load of 220,480lb. (100,000kilos.), reduced to a standard length of about 39¼in. (1m.).

Column 9 shows that the relative shortening reduced to 1m. of length was as 375 : 330 : 260 : 210 : 95 : 60 : 20, while in order to produce a compression of $\frac{1}{1000}$ part of the length required loads, as given in column 10 of the table, of 59, 63, 79, 108, 238, 374 and 771 times 1000lb. about. In order to determine the elastic compressibility of these flues, the shortening under which permanent set was first observed was noted, as in column 11, and was in the proportion of 390 : 419 : 336 : 320 : 190 : 84 : 158. These numbers are in a regular series, except 419 and 158, corresponding to flues Nos. II. and VII., and is accounted for by the fact that they were made of harder material, as is shown by columns 5 and 6 in the table.

For stationary-boiler flues in Germany, Nos. I. and VI. would undoubtedly be in frequent competition, as they are both designed for similar working pressures; but columns 9 and 10 show that the corrugated flue No. I. is about six times as flexible as No. VI., the Adamson flue, while the latter weighs 54 per cent. more than the former. See column 4.)

In marine engineering those flues which are designed for pressures of about 160lb. are applicable, and hence flues Nos. II., IV., VI. and VII. would be selected according to the British standards, which make a difference between softer and harder material, or such as have a tenacity less or greater than 58,300lb. per square inch, while all other rules are established for the use of softer materials alone. Harder material was used in making flue No. II. solely as a matter of interest to the Schulz and Knaudt Company. Lloyd's rules show but one formula for the Purves flue, for a material having a minimum tenacity of 58,300lb. Probably softer material was not considered applicable for Purves flues, because this would increase the thickness of the metal considerably, and hence make the weight excessive; while flue No. VII. shows that it has but one-seventh the longitudinal flexibility of No. IV., which is 13 per cent. thicker and 22lb. heavier.

In comparing results it became desirable to know whether the relative flexibility of the flues was in accordance with a fixed law, and whether it could be explained by the well-known theory of elasticity. Should the observed results agree with these laws, it would on the one hand be good evidence that the tests had been made correctly, while, on the other, it would prove the possibility of calculating the behaviour of any given design of flues. For this purpose we shall consider corrugated flues alone, and assume a strip to be cut from one of a length of one-half of one corrugation, as in hatched portion of Fig. 8, in which S is the thickness of metal, one unit wide.

The pressure on the ends of this strip is p, with a lever arm w (depth of corrugations), of the couple of forces. According to the elastic theory, the compression, z of the strip in the direction of the force p will be equal to $Z = \frac{pw^3}{aEI}$, in which E is the coefficient of elasticity and I = the moment of inertia of the cross section of the strip, and a is a constant, depending upon how the ends of the strip are held. In this formula the material is considered incompressible. Let P represent the total end pressure applied, D the diameter of flue; then we shall have, as there are nD unit strips in a complete flue, $pn\mathrm{D} = \mathrm{P}$, or $p = \frac{\mathrm{P}}{\mathrm{D}n}$. Substituting this value in the above formula, we have the compression of the whole flue, as referred to one-half corrugation: $Z_1 = \frac{\mathrm{P}w^3}{a\mathrm{EID}n}$, in which substituting the moment of inertia of a rectangular section of S in height by its value $\mathrm{I} = \frac{\mathrm{S}^3}{12}$, we have $Z_1 = \frac{\mathrm{P}w^3 12}{a\mathrm{ES}^3\mathrm{D}n}$. As the ends of these strips are all held in the same manner, a is a certain constant, as well as E for low steels. As the corrugations in five flues were identical, m becomes constant, and $\frac{12m}{a\mathrm{E}n}$ is therefore constant, and can be represented by the value C, hence the compression of the entire flue under a load P becomes $Z = \frac{\mathrm{P}w^3}{\mathrm{S}^3\mathrm{D}}\,\mathrm{C}$ when thickness is S, depth of corrugations is w, and diameter D.

Thus calculating the compression of the different flues by substitution in this formula, and plotting the results obtained, we obtain the dotted lines shown in Fig. 9. The value of constant C has, of course, been chosen with relation to the size of the diagram.

From this we observe that the curves obtained by calculation are very similar to those obtained by observation of tests; considering that the thickness of plates such as are used for flues often varies by more than 10 per cent., and that this dimension is used in the above formula in the third power, it becomes apparent that the slight differences between observed and calculated curves can be readily accounted for. Hence the legitimate conclusion to be drawn from our experiments is that the flues behaved under test in accordance with fixed laws; that, allowing for slight errors due to the smaller loads applied, the results observed agree very closely with the calculations. Even flue No. II., showing a tenacity of 66,000lb., gave equally close results, when comparing compression observed with that obtained from calculation by the above formula. It is evident that this should be so, as the tenacity does not enter into the formula, and hence cannot affect the longitudinal flexibility of the flue, but merely the ultimate resistance or permanent set.

It remains to be shown whether the conditions existing during the tests correspond with those obtaining in boiler practice. The temperature of the flues on the day of the test was 59° F., while that of a flue in a steaming boiler would be many hundred degrees, varying, of course, with the steam pressures and the condition of the fire and gases. According to investigations by Prof. A. Martens (in "Zeitsch Ver. deutsch. Ingenieure," 1883, page 126, and "Stahl und Eisen," 1888, page 76), there is no difference in the properties of low steels up to a temperature of 572° F., after reaching which the material begins to grow weaker. Since we know that the temperature of boiler flues does not reach 572° F., we are quite certain that the results obtained in the hydraulic press represent those existing in boilers in service, and as we have seen that the ultimate resistance of the material does not affect results, we are warranted in the above assumption.

The circumstance of unequal expansion due to difference in temperatures on opposite side of flues causing distortion, is a different question, and is the cause of eccentric and unequal pressures on the ends of the flues.

The Design and Erection of Flour Mills on the Roller System.—XX.

THE wheat, after leaving the cockle, barley, and rye cylinders, is passed through a scourer, or smut machine. It is then sufficiently clean to be passed on to the break rollers in the flour mill. The object of scouring the wheat is to break up any clay, earth, or smut balls; also to loosen any dirt attached to the wheat. The brush machine rubs off the beard and other surface impurities. Both machines run at a high speed, and it may be as well to state that they are the most dangerous machines in a flour mill, so far as fire is concerned, and are looked upon with great suspicion by insurance companies. In small roller plants the smutter and brush are combined in one machine, usually of a horizontal design; but we shall here consider each as a separate machine.

It may be surprising to some modern millers, and also to some milling engineers, to learn that the idea of scouring the wheat is about 230 years old. In the year 1672 an Englishman, Richard Haynis, invented a method of not only scouring the wheat but also of separating other seeds and impurities. Very little is known of the *modus operandi* of this machine beyond the fact that millers in those times were anxious to improve the condition of the wheat before it went to the stones. In the next century we come across a machine invented by Mr. Robert Barlow, which invention proves that Mr. Barlow was a master of the subject of cleaning wheat, as his machine had seven parts, including scouring, application of blast, separation of seeds, and the collection and delivery of all refuse. Another wheat-cleaning machine, the joint invention of Andrew and Robert Meilke (1768), was a step in the right direction. Here the wheat, after passing through a blast to remove light seeds, etc., was delivered into two cylinders—one moving round within the other—covered with punched plates, between the rough sides of which the wheat was scoured. The next invention was by John Milne (1770). This invention consisted of a cylinder of perforated metal, or wire-work, having within it a rotating shaft carrying brushes. The cylinder was set with its axis slightly inclined, so that the wheat, after being subject to the action of the brushes, would pass out. At the same time the smut and small seeds would be driven through the interstices of the cylinder. It should be noted that John Milne's invention (now nearly 122 years old) constitutes the principal parts of the modern wheat scourer and brush machines.

The difference between the old and new wheat scourer is that in J. Milne's machine the cylinder was set with its axis slightly inclined, while the modern wheat scourer has its cylinder either vertical (American design) or horizontal, of a conical form. In both modern machines the cylinder is covered with perforated steel, and the action of the beaters or brushes is to drive the small seeds and dirt through the cylinder interstices. The only improvement that has been effected in this machine by modern milling engineers is that the wheat before reaching the cylinder passes through a chamber connected to a suction fan, so that the up-current of air can draw away any light seeds or dust, and the same action is repeated after the wheat has been scoured before leaving the machine. The scouring action of the machine is precisely the same as it was 122 years ago.

The writer's object in tracing back the history of the wheat scourer and brush machine is to show that the millwrights of 100 years back settled once and for all how wheat was to be scoured, etc. This is proved from the fact that scouring wheat is to-day carried on (with very slight modifications) in the same manner as it was a century ago.

It would serve no purpose to describe all the patents taken out for machines to scour wheat. Emery wheels have been tried, but this design did not find favour: the abrading action set up was supposed to create friction between the grains of wheat; and thus wheat cleaned wheat, and so on. The latest development of wheat cleaning is the table brush.

The table brush in appearance and action resembles an under-runner millstone. A perforated table which revolves is keyed on a vertical shaft; the perforations are so formed as to throw the grain in a shower against the surface of a brush which is suspended just above the surface of the perforated plate. This brush can be adjusted when the machine is at work.

The action of this machine is similar to a pair of millstones grinding wheat, by the brush being lowered upon it. The wheat also passes through an exhaust chamber prior to being brushed, and before leaving this machine the action is gentle; but the question arises, Will a gentle action be sufficient to clean wheat? Is it possible to make brushes do the work of iron beaters? To answer this, we shall examine the requisites of a good scouring machine.

The first and most important action of a wheat scourer is that the wheat should not be broken up by the beaters. If the wheat is broken, then it is evident that the beaters are travelling too quick, or the feed is not sufficient for the capacity of the machine. The beaters, as stated before, must break up smut and other dirt balls, and also loosen the adhering dust, breaking off certain hair-like projecting appendages, termed the furze or beard, and detach as much as possible of the woody fibre forming the exterior bran. It is evident that to accomplish this end the grain must come into violent contact with some hard metallic or other surface; but for polishing the wheat, the action of elastic fibres, arranged as brushes, will give good results. The amount of unsightly and deleterious material removed by brush machines from wheat that appears to be clean is astonishing.

For the above reasons the writer fails to see how one machine can combine in itself the two actions—viz., scouring and polishing; and he believes that the old-fashioned smutter, either vertical or horizontal, is destined to hold its own for some years to come.

The wheat brush after being cleaned, or after leaving the machine—usually the latter,—is sent to the clean-wheat silos; but, as stated before, it should be weighed in order to ascertain the loss of weight through cleaning. It is usual to clean wheat of one kind by itself, also to have a number of clean-wheat silos for storage purposes. Underneath the silos are fixed automatic wheat mixers, so that any or all of the cleaned wheats can be mixed according to their respective qualities. The mixing of wheats is an art requiring keen discrimination. This can only be acquired by long experience as an observer of the manufacture and of the results produced; it does not enter in any way into the engineer's duties.

Concluding Notes on the Wheat-cleaning Department.—1. Iron should enter very largely in the construction of all wheat-cleaning machinery, also the worms and elevators; and if the spouts are made of timber, they should be lined with a strong gauge of black iron, screwed to the sides and bottom of all timber spouts.

2. All spouts feeding machines should be fitted with hand-hole doors near the feed hopper of the machine, so that in the event of that machine "choking" and filling up, the force of the feed will throw open the small door, and the feed will run on the floor and soon arrest the attention of the attendant. This arrangement will prevent a block throughout the entire wheat-cleaning department.

3. All bearings, more especially the bearings for high-speed shafts, should be protected against the dust and grit that is always to be found in a screen mill. Glass needle lubricators, fitted to every bearing, will prevent hot bearings; and if a little care is exercised when the lubricator is fitted on, all the bearings in a mill will not require much attention, beyond supplying the lubricators with oil.

4. It is most important that no gas lights should be near any machine, or even near any worm, elevator, or exhaust trunking. If it is possible to abolish gas-light in the mill so much the better, more especially in the wheat-cleaning departments. Only a few weeks ago a very large flour mill was completely burned down through some dust coming into contact with a gas jet. An explosion occurred, and before many minutes the whole place was in flames. The writer once (and he hopes for the only time in his life) saw an explosion of stive dust caused by a gas jet. The report was like thunder, and the flame travelled or followed the dust. The writer traced scorched wood for 50ft. or 60ft. away from the explosion.

Electric light is the best kind of artificial light for a flour mill, on account of the safety it affords and freedom from explosion. The writer has often wondered why millers as a body do not go in for electric lighting, as in many cases they have the power required to light the mill, running to waste.

(*To be continued.*)

Shipbuilding Notes.

The Cunard Line steamer "Lucania," a sister to the nearly-completed "Campania," will be launched by the Fairfield Shipbuilding and Engineering Company towards the end of this month.

On the 3rd inst. there was launched from Messrs. C. S. Swan and Hunter's West Yard, Wallsend, a steel steamer of the following dimensions:—Length over all, 300ft.; breadth, 38ft. 9in.; depth moulded, 20ft. 6in. Her engines, which have been built by Messrs. Robert Stephenson and Co. Limited, are exceptionally powerful.

On the 31st ult. Messrs. Wood, Skinner and Co. launched from their shipbuilding yard, at Bill Quay-on-Tyne, a screw steel steamer. The vessel is of the following dimensions:—283ft. long, 37ft. 6in. beam, and 20ft. 8in. depth moulded. She has a cellular double bottom for water ballast, all fore and aft, and will be fully equipped with all the latest improvements. The North-eastern Marine Engineering Company, Wallsend, will supply and fit the engines, which are of the triple-expansion type, having cylinders 20½in., 34in., and 56in., with 39in. stroke, capable of indicating 1000H.P., and propelling the ship at a speed of 9½ knots loaded.

Official intimation has been given that the new first-class cruiser "Grafton," building by the Thames Ironworks Company, will be delivered from the contractors early this year. The "Grafton" is one of nine protected cruisers of the "Edgar" type provided for in the Naval Defence Act, and will be the first of the five building by private firms to be delivered to the Government authorities. The Admiralty have issued instructions for the "Grafton" to be received at Chatham Dockyard, where she is to be armed and completed for sea. The "Grafton" has been built from the designs of Mr. W. H. White, C.B., Director of Naval Construction, and is 360ft. in length, 60ft. in breadth, and has a displacement of 7350 tons. She has been fitted with machinery supplied by Messrs. Humphreys, Tennant and Co., her engines being estimated to develop 12,000H.P. under forced draught, and 10,000H.P. under natural draught, her estimated speed under forced draught being 19·75 knots, and under natural draught 18·75 knots. The armament of the "Grafton" is to consist of two 9·2in. breechloading guns, ten 6in. quick-firing guns, and seven 3-pounder and 6-pounder quick-firing guns. The cost of the ship, including guns and equipment, is estimated at £370,778.

Metal-cutting Tools.

(*Continued from page 228, vol. xii.*)

The Shell Reamer.—Where extreme accuracy and smoothness of bore are desired, it is sometimes the practice to use a second head, in the form of a shell reamer. The body is made of cast iron and in all respects like the regular head, except that in place of the boring cutters in the latter there are seats planed the entire length, and the reamer teeth set in, similar to those in the ordinary shell reamer. Of course, this will not pay unless there are a sufficient number of holes of the same size to be finished to warrant the expense of the tool, as it will answer for the one size only; and if made of the adjustable type, by tapering the teeth and their seats, and even by providing several sets of the former, no very great range of sizes is possible. For the heaviest class of work, such as the bores and flanges of marine, pumping, and blowing-engine cylinders, the vertical type of bar should be used. The necessity for placing the cylinders on end during the operation is owing to the fact that if placed in a horizontal position the mere weight of the casting will cause it to spring sufficiently and so cause the bore to flatten to a very appreciable extent, and an "oval cylinder" will be the result. Two forms of mill are used for the work. The most usual is that in which the form of bar, etc., last described, is stationary and the work is carried on a revolving table. In the other the work is stationary and the bar is rotated by any suitable mechanism. The latter rig is best suited to special work, where temporary facilities are required, as the casting may be merely levelled up on the floor, in any convenient location, and a temporary hole provided for the tail bearing and end of bar. The drive may be led to the gearing at the upper end of the bar by means of rope belting, which will admit of turning as many corners as required by the relative positions of line shaft and bar.

It not infrequently happens that boring must be done in work for which the power drive is not available or convenient. In this case it may be done by hand power, or by the use of crank and suitable gearing. The bar is carried in bearings bolted or clamped to the work and carefully adjusted to the circle of hole laid out on casting at both ends of bore. This adjustment is best made by using a bent scriber keyed into cutter slot in bar, and by turning the latter to all points in the circle the setting may be made extremely accurate. While this method of boring might appear to be extremely crude and incapable of giving very satisfactory results, such is not the case. Of course, all depends on the skill of the workman, but if this be adequate, the work will be as true and clean—and not so very much slower—as can be done in the best boring machine.

Portable boring machines have of late years come into very general use—probably as a matter of development from the introduction of the Flanders cylinder borer—the pioneer of this class of tools. They are made for use by either hand or power driving. Convenient devices are provided for attaching and adjusting them to the work, also a full set of bars, cutter heads, and other accessories for adapting them to almost any class of work. For boring engine cylinders and rotary valves seats, without removing the parts from position, and other operations of a similar character, they are a very useful and efficient tool, and effect a large saving in cost of the work.

(*To be continued.*)

Electric Lighting at Cardiff.

It is not intended that Cardiff shall be behind other towns in the matter of electric lighting, but although powers were obtained by the Corporation so long ago as in July, 1891, scarcely anything has been done beyond the drawing up of a scheme. Something must, however, be done before July next, when the two years expire within which a commencement must take place, or the provisional order will lapse. Accordingly, the project has now been submitted rather hastily to the Local Government Board for sanction, and for powers to raise a loan to cover the cost, estimated at nearly £33,000. It is intended to erect a central station on Canton Common for the supply of electric light, at first to the centre of the town, which constitutes the compulsory area, and subsequently to be capable of easy development for the supply to the whole of the borough. The high-tension transformer system has been recommended for adoption by Mr. W. H. Massey, who has been appointed consulting electrical engineer to the Corporation. It is also intended to furnish current for the operation of electric motors. The Corporation is now awaiting the arrival of an inspector of the Local Government Board to hold an inquiry into the matter before the scheme can be carried out.

Notices of New Books.

Mechanical Drawing: Progressive Exercises and Practical Hints. By Charles W. MacCord. New York: John Wiley and Sons. London: Gay and Bird.

Professor MacCord, who is well known as the author of an excellent book on kinematics, and was formerly Ericsson's chief draughtsman, has prepared a work on mechanical drawing which is in many respects a distinct advance on any work of a similar character that has yet appeared. The first two chapters contain instructions and exercises calculated to train the eye and the hand in the use of instruments, as well as to inculcate the exceedingly useful habit of exercising forethought, judgment, and taste in matters of general arrangement and detail. Prof. MacCord's treatment differs from that of many others, inasmuch as he appears to have a very pronounced objection to the use of descriptive geometry in the early stages of the work, the author's professed endeavour being to teach the student to draw objects in a "matter-of-fact way." Chapter III. deals with the principles of projection, and Chapter IV. with objects in inclined positions. Interesting chapters follow on the helix, the intersections and developments of surfaces, etc. The second part of the work consists of the third edition of the author's "Practical Hints for Draughtsmen." In this section various methods of representation are given, which the author considers are "in many cases better than the precise ones of projection; for mechanical drawings often convey false impressions by too close adherence to the truth, and become obscure by being too exact." In Chapter I. of this division of the work Prof. MacCord boldly defies the rules of projection, and lays down rules for the guidance of the draughtsman which have much to recommend their adoption—always provided that the method given is generally followed. Chapter II. is on the drawing of bolts, screws, etc.; Chapter III. on freehand sketching; and Chapter IV. on drawing instruments and materials. It is explained that the latter chapter is given at the end instead of at the beginning of the work owing to the fact of the second half of the book being published some time before the first. We can cordially recommend Prof. MacCord's work, but trust that in a future edition—which should, we imagine, soon be in request—the two parts of the work will be combined and more systematically arranged. As usual, the publishers have produced the work in that high-class style for which they are so justly renowned.

Modern Views of Electricity. By Oliver J. Lodge. London: Macmillan and Co.

With the practical applications of electricity multiplying almost daily, there naturally develops a desire for a knowledge of what electricity is, and to those who wish to post themselves up in the modern theory of electricity, we can cordially recommend Professor Lodge's lucid little treatise, the second edition of which has just been published. A new chapter on "Recent Progress," revised by Professor Fitzgerald, has been added, and also five new sections by Mr. A. P. Chattock relating to Gaseous Conduction. The latter writer puts forward the molecular-chain theory of gas discharge as being the only one capable of giving a simple and understandable explanation of the many striking features of this form of discharge. He points out, however, that the chain theory is not of itself sufficient to account for the very marked differences between the passage of positive and negative electricity from an electrode, but up to the present no explanation of more than a tentative character has been put forward. Mr. Chattock considers it as not unlikely that the cause of dissymmetry between positive and negative discharge is electrolytic in character; chemical changes on the vapours of electrolytes, when subjected to sufficiently strong electrostatic stress, also point in the same direction.

Professor Lodge concludes his chapter on Recent Progress as follows:—"Progress towards the direct manufacture of light is apparently going on in two different directions. One is by the attempt to construct mechanism or discover principles able to cause and maintain electric oscillations of the desired frequency; the other is to depend on the properties of certain molecules disturbed and thrown into vibrations by comparatively slow electric oscillations, and being thus caused to phosphoresce. This last may seem a short cut to the desired result, but it has rather too strong a family likeness to the present blindfold method of coaxing molecules to radiate—viz., by jogging them with heat—to be quite satisfactory. The direct-maintenance method may lie dormant longer and be far from the achievement of success, but it seems to have a deeper comprehension of actual conditions latent within it. This latter method fails at present from insufficient frequency; the phosphorescence method fails at present from insufficient intensity."

Handybooks for Handicrafts. By Paul N Hasluck. London: Crosby Lockwood and Son. 1s. each.

We have on several occasions had the pleasure of commending Mr. Hasluck's series of handybooks to the notice of our readers. To workmen, students, and amateurs in the several handicrafts these little books have proved of considerable value, and the publishers have no doubt acted wisely in reducing the price of each to one shilling. Considering that each volume consists of about 144 pages and contains nearly 100 illustrations, it will be seen that the books are remarkably cheap. The volumes at present issued are the "Metal Turner's Handybook," "Wood Turner's Handybook," "Watch Jobber's Handybook," "Pattern Maker's Handybook," "Mechanic's Workshop Handybook," "Model Engineer's Handybook," "Clock Jobber's Handybook," and the "Cabinet Worker's Handybook."

The Principles of Patternmaking. By a Foreman Patternmaker. London: Whittaker and Co.

This is a useful rudimentary treatise on patternmaking, specially written for apprentices and students in technical schools. Chapters are given on first principles, tools, joints, engine cylinders, gear wheels, miscellaneous examples, and pattern turning. A capital glossary of terms used in patternmaking and moulding is appended. We have no hesitation in recommending the book to technical students and apprentices.

Electric Lighting and Power Distribution. By W. Perren Maycock. London: Whittaker and Co. Part I. 2s. 6d.

This appears to be an elementary manual specially prepared for students preparing for the ordinary grade examinations of the City and Guilds of London Institute, and will serve admirably as an introduction to more advanced works. A large number of illustrations are given, and also several sets of questions for the use of teachers.

We have also to acknowledge the receipt of a copy of the small treatise on "Wrought Iron and Steel in Construction," issued by the Pencoyd Ironworks, Philadelphia In view of the increasing use of steel in structures, the present edition has been entirely rewritten. The subjects discussed have reference solely to the output of the Pencoyd works; but the book is, notwithstanding, of general interest to the engineer and architect.—"The World-wide Atlas of Modern Geography," published by Messrs. W. and A. K. Johnston, Edinburgh, is a somewhat small but very comprehensive atlas. The index is a very full one, and an interesting introduction is given on geographical discovery in the 19th century.—Messrs. Houston, Stanwood and Gamble, of Cincinnati, have issued a "Ready Reference for Engineers and Steam Users," by J. B. Stanwood. It contains a useful collection of data on the steam engine, which will be found of value to engineers. Some particulars are appended of the firm's single and double-cylinder slide valve engines.—The Link Belt Engineering Company, of Nicetown, Philadelphia, have published a small treatise on "Power Transmission by Manila Rope." Several installations on the so-called "American" system of rope-driving are illustrated, but we think the book might be considerably improved by the addition of some useful data on the subject. — The "Engineers' Gazette" Annual (the Tower Publishing Company, 1s.) contains a deal of information of interest and value to the marine engineer. The matter is arranged in alphabetical order according to the headings, which is not to our mind altogether advantageous. A number of notes and anecdotes are appended, and among these we find one referring to Sir Joseph Whitworth. It is stated that he was born in Lambeth in 1805. We are, however, under the impression that the celebrated engineer was born at Stockport, on December 23, 1803. The date of his death, here given as 1886, is certainly wrong, as this event occurred on January 22, 1887. Several other points mentioned in this sketch are, if not exaggerated, certainly out of place, for not only do they serve no good purpose, but tend to lower a clever engineer in the estimation of many.—The Electrical Power Storage Company Limited have again issued their handy date-indicating blotting pad, combined with a price-list of the E P.S. storage batteries. We notice that the company is prepared to exchange at certain rates the newest forms of cells for the various old-type cells previously manufactured by them.—We have also to acknowledge the receipt of a very effective calendar from the Magnolia Anti-Friction Metal Company Limited, Queen Victoria-street, London, and 76, Haworth's Buildings, Manchester. The lettering is blocked in aluminium foil, and the general appearance is excellent.—Messrs. M. Wells and Co., Hardman-street Oilworks, Manchester, have issued a calendar, which is most tastefully designed and printed.—Messrs. Wyckoff, Seamans and Benedict, of Gracechurch-street, London, have also favoured us with one of their Remington typewriter calendars. This is a beautiful specimen both of engraving and printing, and is in every way a model of artistic excellence.

Trade Notes.

Contracts have just been made for 216 locomotives for the Prussian State Railways. They were given solely to German firms.

Messrs. Mather and Platt Limited, Salford, have contracted to supply the engine and dynamo for the electric lighting station at Dundee.

Messrs. John Shaw and Co., Maryhill Ironworks, Glasgow, have secured the order for the 1200 tons cast-iron pipes required for the Iquique drainage contract.

Messrs. Whitworth and Co. Limited Manchester, have received an order from the Swedish Government for three 24-centimetre guns, at a price of £3200 for each gun.

The Yorkshire Engine Company have just completed a large beam for the beam pump of the Tinsley Coal Company. It is 40ft. long, and weighs about 30 tons.

Messrs. John Fowler and Co. Limited, Leeds, have just supplied a 35H.P. compound engine to the Ogmore Valley Electric Light and Power Supply Company, South Wales.

Messrs. Paterson and Cooper, of Westminster, London, are carrying out an electric lighting installation at the shipbuilding yards of Messrs. Workman, Clark and Co., Belfast.

The Newton Electrical Engineering Company, of Taunton, have recently carried out an installation of electric light in the mills of Messrs. Redler and Co., Bathpool, Taunton.

Messrs. Gourlay Brothers and Co., engineers and shipbuilders, Dundee, have contracted to build new boilers, engines, and other machinery for the Danish steamer "Niord."

The directors of the Highland Railway Company have placed an order with Messrs. Brown, Marshall and Co., of Birmingham, for ten lavatory third-class carriages and twelve goods brake vans.

A first consignment of the 50,000 tons of steel rails which the Ebbw Vale Steel, Coal and Iron Company Limited is supplying to the Transvaal Railway Company has been despatched from Newport.

The contract for the construction of the new Wirral Railway, from Bidston to Hawarden Bridge, for the Manchester, Sheffield and Lincolnshire Railway, has been awarded to Messrs. Monk and Newell, Bootle.

The exports of cutlery from Sheffield to the United States during the closing quarter of 1892 amounted to a value of £40,493, against £42,125 in the corresponding period of 1891. For the whole of last year the value was £127,000, as compared with £116,000 in 1891. The M'Kinley tariff still prejudicially affects the cutlery trade with America. In 1890, before the tariff came into operation, the exports were £234,000. The cheaper classes of goods have been driven out of the market, whilst the best qualities are in good demand.

Sugar-making Machinery.

XXV.

Miscellaneous Details.—We shall now add here a few details of various parts illustrating variety of design and different methods of construction.

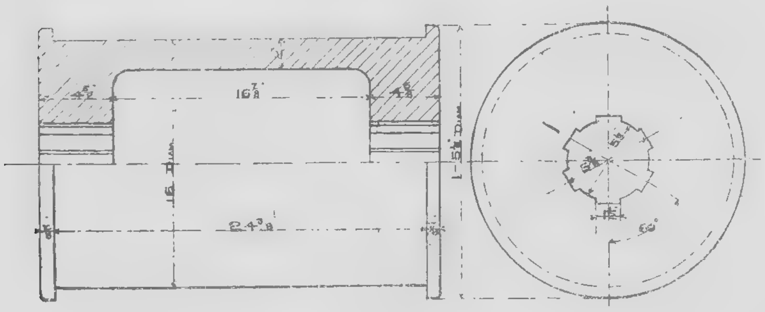


Fig. 55.

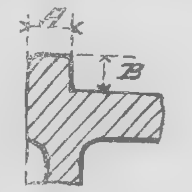
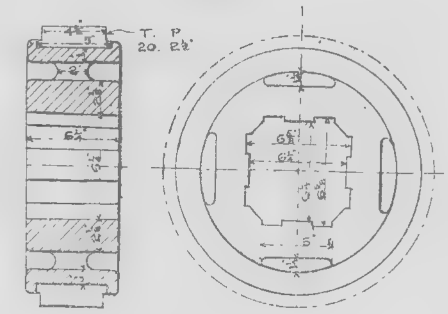


Fig. 56.

Fig. 58.



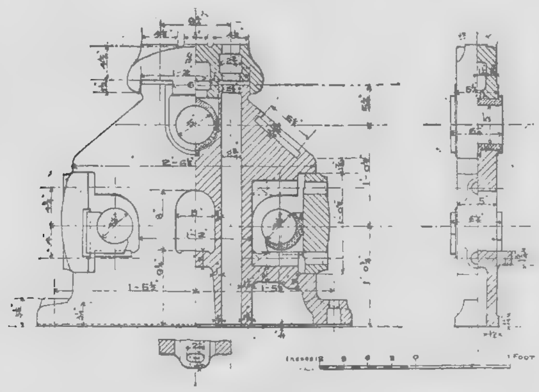


Fig. 57.

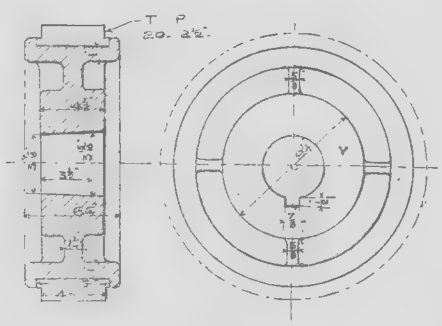


Fig. 59.

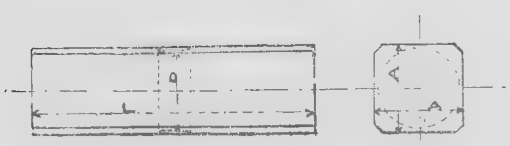


Fig. 60.

Fig. 55 shows the roller case for a mill having rollers 16in. diameter and 24in. long, which is staked on to the gudgeon with six keys. This is a method of construction not often adopted now, especially in shops well equipped with special boring tools and hydraulic presses for forcing on the cases.

Fig. 56 shows the form of the flanges for the side rollers of mills, and Table XX. gives the dimensions for a variety of sizes of rollers.

TABLE XX.

Rollers.	A	B	Rollers.	A	B
in. in.	in.	in.	in. in.	in.	in.
40×78	2¼	1½	24×48	1⅝	1⅛
36×84	2¼	1½	22×42	1½	$1\frac{1}{16}$
34×78	2¼	1½	20×30	1⅜	$1\frac{1}{16}$
33×84	2¼	1⅜	19×36	1¼	1
32×72	2⅛	1⅜	18×30	1¼	1
30×60	2	1¼	16×24	1¼	⅞
28×72	2	1¼	14×21	1⅛	⅞
26×60	1¾	1⅛	12×12	1	¾
25×54	1⅝	1⅛	10×12	⅞	¾

Fig. 57 shows a well-designed cheek or headstock for a 16in. × 24in. mill. The sketch is fully dimensioned, and requires no further description.

TABLE XXI.

Mill Rolls.	in. 20	in. 22	in. 24	in. 26	in. 28	in. 30	in. 32	in. 34	in. 36	in. 40	in. 48
A	7⅛	8	10¼	11	12	13½	15	16¼	16	18½	21

TABLE XXII.

Dia. Rolls.	Dia. Bolt.	A	B	C	D	E
in.	in.	in.	in.	in.	in.	in.
12	1	1¾	2¾	1⅜	6	6
14	1	1¾	2¾	1⅜	6	6
16	1⅛	1¾	3	1½	6	7
18	1⅛	1¾	3	1½	6	7
20	1¼	1⅞	3¼	1¾	7	8
22	1⅜	2⅛	3½	2	8	10
24	1½	2⅛	3¾	2	8	10
26	1¾	2¼	4	2½	10	10
28	1¾	2¼	4	2½	12	10
30	2	2½	4¼	2¼	12	12

Figs. 58 and 59 show roller pinions for above size of mill. Fig. 58 shows the top roller pinion, which has 20 teeth 2½in. pitch and 4½in. wide on the face, and shrouded to the pitch line. It has a square hole cored through it to fit end of gudgeon, to which it is staked with eight keys. Fig. 59 is the side roller pinion, having the same pitch and number of teeth. The eye, however, is bored taper, and fitted on to end of gudgeon with one key ⅞in. wide. The connection between the top roller gudgeon and the second motion shaft of the compound gearing is made in the smaller sizes of mills by a coupling, the prongs of which engage with corresponding prongs on the top roller pinion. In the larger sizes of mills the connection is made by means of a short square shaft and two coupling boxes, generally made of cast iron. The coupling boxes are very often made square in the body and turned at the ends, and two wrought-iron hoops shrunk on. Some prefer them round with a square hole cored through, and bound with wrought-iron hoops at the ends. In some instances the coupling boxes are made of cast steel.

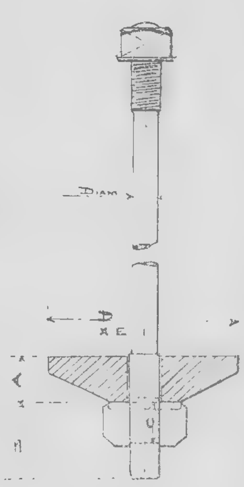


Fig. 61.

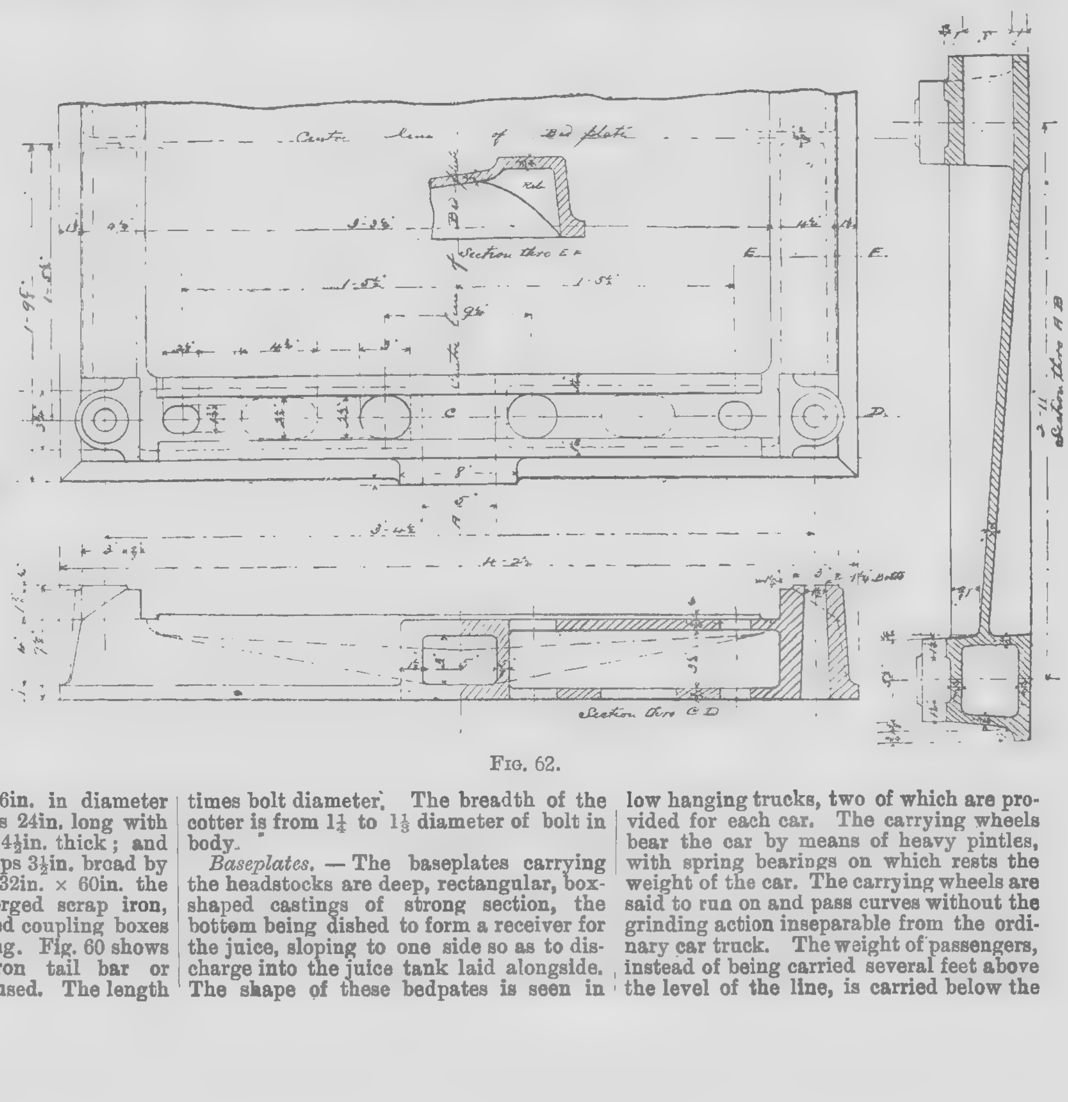


Fig. 62.

A mill with rollers 36in. in diameter will have coupling boxes 24in. long with 14½in. square hole, metal 4½in. thick; and bound at the ends by hoops 3½in. broad by ⅞in. thick. For a mill 32in. × 60in. the tail bar would be of forged scrap iron, 4ft. 6in. long, with hooped coupling boxes 21in. square and 20in. long. Fig. 60 shows the form of wrought-iron tail bar or coupling shaft generally used. The length of the bar is generally about two and a quarter times to two and a half times the length of the coupling. They are generally notched down in the centre at D to about ½in. in diameter less than top roller gudgeon, to form a breaking place should any excessive strain come on the mill. The size of the tail bar, we may note, varies a good deal with different makers, but should always be less in diameter than the top roller journal.

Table XXI. gives the suitable dimensions for such bars.

Fig. 61 shows the style of bolts and cast-iron washers used for bolting the mill beds to the foundations.

Table XXII. gives the main dimensions for the bolts, washers, and cotters. The washers are usually square or rectangular, and the width generally about six times diameter of bolt, and the thickness from 1¼ to 1½ times bolt diameter. The breadth of the cotter is from 1¼ to 1½ diameter of bolt in body.

Baseplates. — The baseplates carrying the headstocks are deep, rectangular, box-shaped castings of strong section, the bottom being dished to form a receiver for the juice, sloping to one side so as to discharge into the juice tank laid alongside. The shape of these bedpates is seen in Figs. 46 and 48. Fig. 62 shows also in detail the bedplate for a small combined mill, having rollers 16in. diameter by 24in. long, from which the general form of such baseplates will be clearly understood.

(*To be continued.*)

A New Elevated Railway System.

Under the title of the Pruynway system, a new method of electric railway for high-level traffic has been devised by Mr. H. S. Pruyn, of New York. We condense the following from a description by the inventor, extending over five columns in an American paper:—The line and its structure stand on posts sufficiently high to permit of a free passage for the public below, and to prevent all interference. The structure consists of a horizontal girder, with a rail on the top of it, and having two current conductors carried under the lower flanges, where they are not only insulated, but protected from damage by the weather or any other cause. Slightly above the level of these current conductors, and between them and below the structure, is a space for telegraph, telephone, light or other electric wires, which are also protected from interruption by snow, ice, or other causes. These conductors being firmly fastened and completely protected, the danger of a short circuit or of leakage of current is claimed to be avoided. In this system the current does not depend upon the ordinary ground circuit for its return. It first passes from the generating dynamos (which are arranged at suitable intervals along the line) out through the conductor at one side of the structure, and is picked up and led by a suitable truck conductor to the motor on the car; then, after having performed its work in driving the carrying wheel on the top of the main rail—that is, on the top of the girder,—it passes through another conductor into the opposite guide wheel below, which delivers it to a return conductor, which leads the current back to the generating dynamo. This arrangement, it is asserted, prevents induction and short-circuiting, etc. At the top of the truck upon which the car is arranged are carrying wheels which rest upon the before-mentioned main rail; at the bottom of the truck are two guide wheels, one of which picks up the current from the conductor on one side of the structure, whilst the other guide wheel returns it through the conductor on the other side after it has done its work of driving the motor which rotates the carrying wheel on the main rail or track. The weight of the car and its load are carried low on either side of the track rail—largely below. The strengthening framework of the car is in the floor, and a large proportion of the weight, in addition to this frame, is in the low hanging trucks, two of which are provided for each car. The carrying wheels bear the car by means of heavy pintles, with spring bearings on which rests the weight of the car. The carrying wheels are said to run on and pass curves without the grinding action inseparable from the ordinary car truck. The weight of passengers, instead of being carried several feet above the level of the line, is carried below the

level of oscillation obtaining with ordinary cars; whilst the construction of the car, with the main weight in the floor framework, tends still further to lower the level of the centre of gravity of the entire moving body as compared with the track rail level. The inventor further states that the pair of guide wheels is prevented from separating beyond a certain limit, sufficient to allow free passage on each side along the power conductors, not only regulating the position of the car on the track, but maintaining an uninterrupted electrical contact for propulsion. It will be noticed that the car is, so to speak, locked to the track and cannot be derailed. This element of safety is an essential feature of the system, for which many advantages are claimed.

The Design and Construction of Stationary Engines.—XLV.

FIG. 189 shows a cast-iron crank of the ordinary shape, as used with moderate steam pressures. The proportions for the various parts are given in Table XXVII.

TABLE XXVII.—CAST-IRON CRANKS.

D = 1·1 D + ⅜in.	a = 1·3d
G = 1·3 D	h = 0·68d
H = 0·8 D	d' = d
L = 1·2 D	d'' = 1·08d
E = 0·6 D	l = 1·3d
—	e = 0·5l

The crankpin in this case is shown let into the eye with a slight taper, and riveted over at the back.

In many horizontal engines the crank is in the form of a disc, which can be turned all over and polished. It also provides for a convenient means of balancing the revolving and reciprocating parts which require balancing in high-speed engines, so as to ensure easy running when the speed of rotation is high.

Fig. 190 shows such a form of crank, and Table XXVIII. gives the leading dimensions for cranks suitable for various sizes of engines.

TABLE XXVIII.—CAST-IRON DISC CRANKS.

Size of Engine. Cylinder.		A	B	C	D	E	F	G	d
Dia.	Str'ke								
7	14	2⅝	⅝	⅝	3	⅝	¾	18	2
8	16	2¾	¾	¾	3½	¾	⅞	20½	2¼
9	18	3	13/16	1	4	¾	1⅛	23	2½
10	20	3¼	⅞	1	4¾	⅞	1⅛	25½	2¾
12	24	3½	⅞	1	5½	1	1¼	30½	3¼
14	28	4	1	1⅛	6½	1	1¼	35½	3¾
15	30	4½	1⅛	1¼	7½	1⅛	1½	38	4
16	32	4¾	1⅛	1¼	7¾	1⅛	1½	40	4
18	36	4¾	1¼	1⅜	8	1¼	1⅝	45	4½
20	42	5	1¼	1½	9	1⅜	1¾	52	5

These proportions are suitable for good strong engines, working up to 100lb. boiler pressure.

For very large engines running at high speeds, such as rolling-mill engines which are suddenly reversed, it is not unusual to make the discs of cast steel, and even to hoop these with rolled steel tyres, turned accurately all over and shrunk on to disc, as shown in Fig. 191.

Another form of crank for such engines is shown in Fig. 192. It is made of cast iron, having a wrought-iron hoop shrunk and pinned on. The crank shown is fantail in shape and balanced, made for an engine having cylinders 36in. diameter by 42in. stroke. The crankpins are 8in. in diameter × 10in. long, and the crank necks 12in. diameter × 10in. long. The crank is 9½in. broad on the face.

For high-class mill engines, where the best class of work is required, the cranks are generally made of good hammered scrap iron, machined all over, and polished. Figs. 193 and 194 show various forms of such cranks, with their proportional parts marked on, which will be found useful in getting out quickly the proper dimensions of such cranks for a given size of shaft and pin. In all important cases it is advisable to check the results obtained by the formulæ already given. But the proportions given in the figures will be found in ordinary cases to agree with modern practice. In Fig. 193 (crank C) the taper of the crank arm is obtained by dividing the metal round the eye at the crankshaft end into four equal parts, and at the crankpin end into three equal parts, and drawing the lines to their respective outer division marks. This method will be found to give a neat taper and sufficient material.

Fig. 195 shows a form of wrought-iron crank, all the labour on which can be machine done in three operations of drilling the holes, planing the sides, and turning the edges, giving the appearance shown in the figure. This plan of making the crank is cheaper than the usual one; but it is questionable if the appearance of the crank is enhanced thereby. It is, however, adopted by one or two good Lancashire makers.

In the large vertical triple-expansion mill engines, of which quite a number have been made lately, the marine type of built-up crankshaft has been adopted. For large shafts this type has its advantages. The smaller pieces facilitate handling, and ensure greater soundness in the various parts, than would be the case if the shaft and cranks were forged in one piece.

(To be continued.)

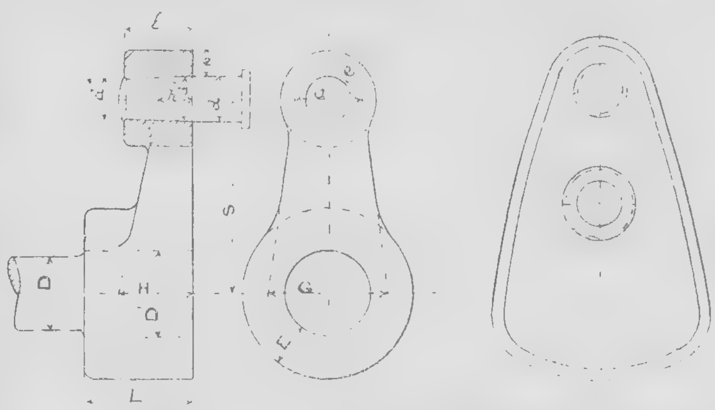


FIG. 191.

FIG. 189.—DESIGN, ETC., OF STATIONARY ENGINES.—FIG. 192.

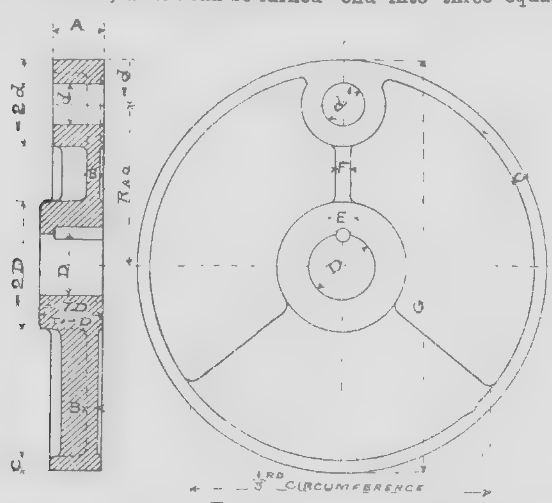


FIG. 190.

DESIGN, ETC., OF STATIONARY ENGINES.

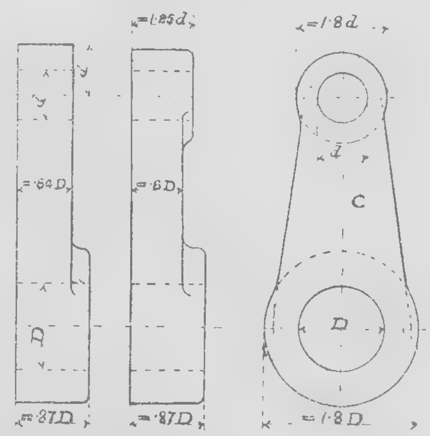


FIG. 193.

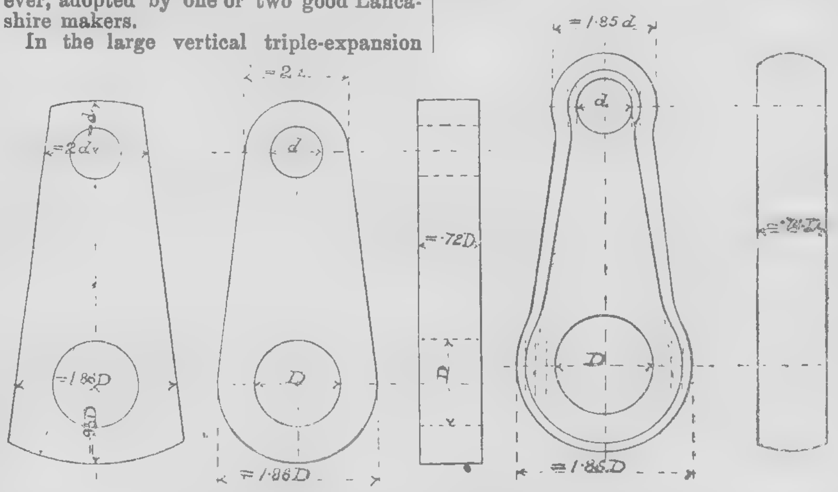


FIG. 194.—DESIGN, ETC., OF STATIONARY ENGINES.—FIG. 195.

Mechanical and Engineering Drawing.—II.

BY A PRACTICAL DRAUGHTSMAN.

The Tools and Materials required by the Student.—As all drawings of mechanical and engineering subjects are made on flat surfaces, and as the most suitable material on which such drawings may be made is paper, the first requisite of the student is a drawing-board, on which to lay or stretch the paper. The board should be made of well-seasoned pine, of a convenient size—say 23in. by 17in., which will take half-a-sheet of imperial paper, leaving ½in. margin all round,—about ⅞in. in thickness, and fitted at the back, at right angles to its longest side, with a couple of hardwood battens, about 2in. wide and ⅞in. thick, the uses of these battens being to keep the board from casting or winding, and to allow of its expansion or contraction through changes of temperature. This latter purpose, however, is only effected by attaching the battens to the back of the board in the following manner:—At the middle of the length of each batten—which should be 1in. less than the width of the board—a stout, well-fitting wood screw is firmly inserted into it, and made to penetrate the board for about ½in., the head of the screw being made flush with the surface of the batten. On either side of this central screw two others, about 3½in. apart, are passed through oblong holes in the battens, and screwed into the body of the board until their heads are flush with the central one; fitted in this way the board itself can expand or contract lengthwise or crosswise, while its surface is prevented from warping or bending.

The *working* surface of the board—or its front side—should be perfectly smooth, but instead of being quite flat it should have a very slight camber, or rounding, breadthways, this latter feature in its construction being to prevent the possibility of a sheet of paper when stretched upon its surface having any vacuity beneath it. The four *edges* of the board need not form an *exact*

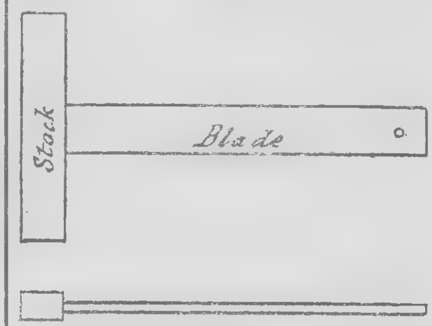


FIG. 1.

rectangle, as much valuable time is often wasted in the attempt to produce such a board; but it will answer every purpose of the draughtsman so long as the *adjacent* edges at the lower left-hand corner of it are at right angles to each other, or square. To produce really good work in the shape of a mechanical drawing, *one* perfectly straight edge only is required on a drawing-board, and that the left one, which is

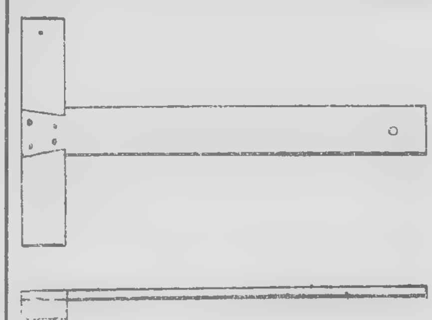


FIG. 2.

always known as the *working* edge; but for the convenience of being able to draw a long line across the board at right angles to its lower edge, this edge is made truly square with that on the left side of the board.

A further improvement in such a drawing-board as above described is made by cutting a series of narrow grooves in the back of it and inserting in its working edge

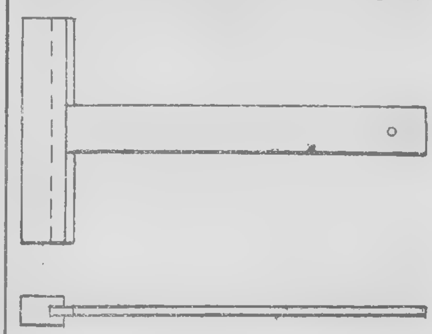


FIG. 3.

a strip of ebony, to help in keeping it true, and to serve as a guide to the stock of the drawing square. There are other kinds of drawing-boards in use; but as the one described has stood the test of many years' service, and finds most favour in drawing offices, a detailed description of them is not necessary here. A reason for giving at such length a description of the kind of drawing-board so universally in use in

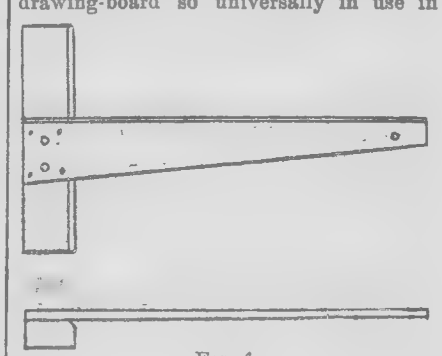


FIG. 4.

modern engineering drawing offices is that it may be the means of inducing students and apprentices capable of handling joiners' or patternmakers' tools to make such a board for themselves, which, if made of good well-seasoned pine, free from knots and shakes, will retain its specially good features for years. Those, however, who

may be unable to accomplish such a feat themselves, may purchase such boards at a reasonable price from manufacturers of drawing materials, who make them a speciality.

The next most important adjunct to the drawing-board, is the drawing, or tee-square. Some inexperienced youths, and even those of larger growth, have a notion that anything will do for a tee-square; but if correct work is to be done the tee-square is as important an instrument to the draughtsman as the drawing-board. It need not, however, be an expensive one, provided a knowledge of what constitutes a really serviceable and efficient tool is possessed by its intended user. As its name implies, it is an instrument in the form of the letter T, the two parts of it being known as stock and blade, the horizontal component of the letter being the *stock*, and the vertical one the *blade*. To form the square the two parts are joined together in such a way as to make them exactly at right angles to each other, the stock, which is applied to the working edge of the drawing-board, being about one-third the length of the blade, and about three times its thickness.

The manner, however, in which the stock is united to the blade determines its adaptability or otherwise to the use made of it by the draughtsman. In some the stock is rectangular in section, and the blade morticed into it, as in Fig. 1. In others the blade is dovetailed and let into the stock for the whole of its thickness, as in Fig 2; or morticed, as in Fig. 1, but fitted with a tongue piece the length of the stock, as in Fig. 3. Neither of these plans is to be recommended; they involve unnecessary work and care in fitting during their manufacture, are more liable to get damaged in their usage, and are practically imperfect as a tee-square in some of its essential requirements. To be perfect in construction, a tee-square should be as light as is consistent with its necessary strength and stiffness of parts; it should be made of suitable material, easily manufactured, put together and repaired, and withal as truly correct as it is possible to be made. Such a square is represented in Fig. 4; it has a taper blade, which is generally about double the width where secured to the stock as it is at the tip. Its tapering form serves two purposes, the primary one being that it adds strength and stiffness to the blade and prevents its buckling—a common fault with all parallel-bladed squares; and the other, its excess of width at the stock prevents it from rocking and gives ample room for securing it to the stock. The blade is also easily and correctly fitted to the stock, and has also one great advantage over all the others in that the set squares used with it are far more easily manipulated than is possible with any of the three previously referred to.

(*To be continued.*)

Metal Trade Memoranda.

Two great deposits of nickel have been discovered in the Kootanie district, British Columbia. The locality is easy of access, but the quality is not definitely known.

Messrs. Boughton, Edmund and Co., tinplate manufacturers, Hendy Works, Pontardulais, will reopen their works, after an idleness of some months' duration, in the course of a few days.

The accountants' quarterly ascertainment just to hand shows that, for the last three months of 1892, the realised price of Cleveland pig iron has been 37s. 7-15d. This is a reduction of nearly eighteenpence. Wages, therefore, fall 2 per cent.

The copper statistics for the month of December, issued by Messrs. H. R. Merton and Co., are not of a promising character. The stocks in England and France, and afloat thereto from Chili and Australia, amount to 55,745 tons, against 53,498 tons in November. The deliveries were some 432 tons less; whilst supplies amounted to 11,696 tons, against 7437 tons in the previous month. Imports from Spain, Portugal, and Chili show a marked increase.

The statistics of the Cleveland Ironmasters' Association, giving the production and consumption of pig iron for the year, have been issued. With reference to December there was a heavy addition to stock of 40,000 tons, whereas in November the increase was 4000 tons. This brought stocks at the end of the year on makers' hands and in warrant stores to 114,339 tons. Four months since stocks were only 46,000 tons. The production was over 239,000 tons, 6000 tons more than in November. 123,000 tons were hematite, and 116,000 tons Cleveland iron from 91 furnaces in blast. The stock at the end of 1891 was 263,000 tons. The production of pig iron for the year was 1,937,469 tons. This is 685,000 tons less than in the previous year, due to the Durham strike. Shipments of pig iron and manufactured iron and steel for the year were 920,000 tons, against 1,271,000 tons in the previous year.

The output of ore from the Marbella Iron Ore Company's mines during the month of December was 3041 tons.

The export of gold from Cape Colony during the month of December amounted in value to £376,635, as compared with £322,000 in the corresponding month of the previous year.

The Custom House returns of the monthly and annual shipments of pig and manufactured iron and steel from Middlesbrough show that the total clearances of pig for December amounted to 49,200 tons, as against 66,286 for the previous month, and 65,907 tons for December, 1891. The month's shipments made the total for the year 632,707 tons, as against 890,162 tons for the previous year. The past year's shipments were the lowest by over 100,000 tons that have taken place during the past 10 years. The shipments of manufactured iron for the past month amounted to 11,483 tons, whilst 18,656 tons of steel were exported. This made the total shipments of manufactured iron and steel for the year 289,088 tons, a decrease of 92,599 tons on the previous year.

New Companies.

Triple-grip Pulley and Power-saving Appliances Company Limited.—This company was registered on the 30th ult., with a capital of £5000, in £1 shares, to purchase or otherwise acquire all patents for the United Kingdom and abroad relating to an improved fibre pulley or rim for covering the periphery of pulleys; to enter into a certain agreement, and to carry on the business of general merchants, pulp and fibre manufacturers, machinists, etc. The number of directors is not to be less than 3, nor more than 7; qualification, 50 shares. Registered office, 88a, Leadenhall-street, E.C.

New Jersey Metal Refining Works Limited.—This company was registered on the 19th ult., with a capital of £50,000, in £10 shares, to acquire and take over the business now carried on in the State of New Jersey, in America, by a company called the New Jersey Extraction Works Limited, and to carry on the business of miners, metal extractors, smelters, and workers and dealers in minerals, ores, metals, and any other combinations. The board of directors is not to consist of less than 3, nor more than 7 directors. Their remuneration is to be fixed by the company in general meeting. Registered by Freshfields and Williams, 5, Bank Buildings, E.C.

Gordon and Fell Limited.—This company was registered on the 4th inst., with a capital of £100,000, in £10 shares, to acquire and take over as a going concern the business of J. E. H. Gordon and Co., electrical engineers, and the goodwill thereof, to carry on the business of a builder and contractor of public works, to prosecute in the United Kingdom and elsewhere the business of electrical engineers, and to maintain electric-light machinery and apparatus, both for public and private purposes. The first directors are to be appointed by the subscribers to the memorandum of association, and their qualification and remuneration may from time to time be altered and fixed by the resolution of a general meeting. Registered by S. Whitehead, 188, Fleet-street, E.C.

Roger Dawson Limited.—This company was registered on the 3rd inst., with a capital of £15,000, in 15,000 shares of £1 each, to acquire by purchase from A. R. Dawson the business of an electric-light engineer and contractor, until recently carried on by him in partnership with A. R. Phipps, under the style of Rashleigh and Dawson, and now carried on by the former alone as sole owner; to enter into a certain agreement as specified in the memorandum of association; and to carry on in the United Kingdom or abroad as may be determined by the directors for the time being, the business of civil, mechanical, or electrical engineers and contractors, including the manufacture, construction, purchase, and sale of all kinds of machinery or mechanical, hydraulic, pneumatic, or electrical appliances, and to prosecute all kinds of work involving engineering or electrical knowledge or supervision. The number of directors is not to be less than 2, nor more than 4. Article 65 of Table A applies to a permanent director. Registered by E. F. Hicks, 3 and 4, Lincoln's Inn Fields, W.C.

The Metal Market.

PRICES CURRENT.

LONDON, Jan. 9.

Copper opened easy and 2s. 6d. down at £46 5s. cash, and warrants were freely offered; but when about 300 tons had changed hands offerings decreased, with the result of a better tone, and eventually a rally of 2s. 6d., three months, which had been done at £46 11s. 3d. to £46 10s recovering to £46 12s. 6d. Cash meanwhile passed at £46 5s. to £46 2s. 6d., and February, prompt, at £46 6s. 3d. to £46 3s. 9d., the latter however, rallying to £46 7s. 6d. In the afternoon realisations were renewed, and three months passed at £46 10s., one month at £46 5s. to £46 2s. 6d., and finally two months at £46 5s. Cash was reported done at £46, and the close is easy at a loss of 7s. 6d. Sales, 1100 tons. Settlement price, £46 2s. 6d.; English tough, £50; best selected, £51 5s.; strong sheets, £59.

Tin has had a quiet market, with a downward tendency, owing to the limited demand. Business commenced with a carrying trade over three months at 5s., and was later done at 2s. 6d., the quantity covering 70 tons; but actual business was confined to a small quantity of cash at £91 5s., and of three months at £91. There was nothing doing later on, but there was no further change in values, the market closing quietly at 2s. 6d. to 5s. decline. Settlement price, £91 5s. English ingots, £94 10s.

Pig Iron opened firm, in sympathy with the Glasgow market, and three months gained 1d., about 2500 tons being put through at 42s. 1d. Cash was also placed at 41s. 10½d., and later on at 41s. 11d., a rise of 1½d.; but in the afternoon the tone was quiet, only 41s. 9d. being bid for prompt delivery. Final rates are unchanged, with the exception of hematite, which is 1½d. better. Sales, 4000 to 5000 tons. Settlement prices: — Scotch, 41s. 9d.; Middlesbrough, 35s. 10d; hematite, 45s. 10d.

Tinplates dull and tending lower. I.C. cokes, f.o.b. London, 12s. 7½d.; Liverpool, 12s. 1½d.; Swansea, 11s. 7½d.

Lead.—Soft Spanish is quoted £9 17s 6d., but there is little doing. English, £10.

Spelter is quiet, with January shipment offering at £18 2s. 6d Silesian special brands, £18 17s 6d from first hands; second hands a shade cheaper.

Zinc Sheets.—Belgian unchanged; V.M. ex ship, £21 15s., sellers; f.o.b. Antwerp, £21 10s. to £21 12s 6d, sellers. Silesian dull at £21 7s. 6d., sellers, ordinary brands.

The Phosphor Bronze Company Limited are quoting the following special net prices, subject to market fluctuations of copper and tin, and to alteration at any time without notice:—

"Cog Wheel" Brand Phosphor Bronze:—

	Ingots. Per Ton. £	s.	d.
For valves, steam fittings, pump rods, etc.	83	0	0
For cogs, plungers, pinions, pumps, etc.	88	0	0
For piston rings, and all high-speed bearings, worm wheels, slide faces, etc.	90	0	0
Special bearing and slide valve metal	85	0	0
Special alloy for propellers, stern and rudder frames	83	0	0

"Vulcan Brand" Phosphor Bronze (superior to the many foreign and other imitations):—

	£	s.	d.
For bearings, bushes, and slide valves	80	0	0
For general engine work	75	0	0

"Duro Metal":—

	£	s.	d.
For wagon and carriage bearings	75	0	0
For hot neck roll bearings	80	0	0

Official Closing Quotations.

	To-day. £ s. d.	£ s. d.
Copper—		
G. M. B.—Cash	46 2 6	—46 10 0
" Three months	46 11 3	—46 18 9
English tough	—	—
Best selected	—	—
Strong sheets	—	—
Tin—		
Fine foreign—Cash	91 5 0	—91 15 0
" " Three months	91 0 0	—91 10 0
Australian—Cash	92 0 0	—92 10 0
Pig Iron—	s. d.	
Scotch warrants—Cash	41 9½	
" One month	41 11½	
Middlesbrough—Cash	35 10½	
" One month	—	
Hematite—Cash	45 10½	
" One month	—	

GLASGOW, January 9.—The pig iron market was irregular and dealing wholly in Scotch, 9000 tons changing hands, including 2000 at 42s. 1d., three months fixed, 2000 at 41s. 11d. cash, and 2000 at 41s. 9½d. one month fixed, with 1s. forfeit in sellers' option. At first the cash price was stiff on apparent scarcity of warrants, but on requirements being met the tone was easier, and the close was 1d. back from the best, Hematite, after being 4½d. dearer, finished 1½d. up. The shipments of Scotch last week were 4317 tons, a decrease of 275 tons compared with the same week last year.

Quotations.

	Highest. s. d.	Lowest. s. d.
Scotch warrants—Cash	41 11	41 10
" One month	42 0	41 11
Middlesbrough—Cash	35 10½	35 10½
" One month	—	—
Hematite—Cash	46 1½	45 10½
" One month	—	—

The stocks in public stores are as follow:—

	Monday. Tons.	Saturday. Tons.
Connal's Glasgow stores	338,437	338,806
Connal's Middlesbrough stores	29,418	29,197
	Saturday. Tons.	**Friday. Tons.**
Hematite — West Cumberland Company	29,017	29,017
North-Western Company	7,500	7,500
Hematite Storage Company	1,650	1,650
Furness Railway Company	11,000	11,000

Official Gazette.

Partnerships Dissolved.

H. W. Buddicorn and J. Abbott, under the style of the Blaina Foundry and Engineering Company, Blaina, Monmouthshire, founders and engineers.

H. Nash and E. Smith, under the style of Henry Nash and Co., Liverpool, tinplate and metal merchants; so far as regards E. Smith.

W. W. Easton and S. E. Waldegrave, under the style of Easton and Waldegrave, Taunton, mechanical engineers.

J. Bigwood, T. C. Bigwood, and H. M. Bigwood, under the style of J. Bigwood and Sons, Wolverhampton, engineers, machinists, millwrights, and ironfounders; as far as regards H. M. Bigwood.

THE BANKRUPTCY ACTS, 1883 and 1890.

Adjudications.

H. G. Lichtenstein and George Breeze, trading as the Alliance Iron Company, Upper Thames-street, City, iron merchants.

Austin Roberts, jun., Halifax, engineer.

Receiving Order.

Austin Roberts, jun., Halifax, engineer.

Order Made on Application for Discharge.

Robert Owen Parry, Chester, ironfounder—bankrupt discharged subject to certain conditions.

The order for the whole of the nautical instruments for the Cunard steamships "Campania" and "Lucania" has been placed by the Fairfield Shipbuilding and Engineering Company with Messrs. J. Sewill and Co., of Liverpool.

Letters to the Editor.

**** We do not hold ourselves responsible for opinions expressed by correspondents.*

**** The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

**** Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

AMERICAN AND BRITISH WORKMEN AND MACHINERY.

To the Editor of The Mechanical World.

Sir,—Allow me to say a few words on this subject, and first I will quote from, to my mind, the greatest man America has yet produced, R. W. Emerson. In his work, "English Traits" (chapter on "Race"), he says: "They are free, forcible men in a country where life is safe and has reached the highest value. They give the bias to the current age; and that not by chance or by mass, but by their character, and by the number of individuals among them of personal ability. Neither do this people appear to be of one stem; but collectively a better race than any from which they are derived." So much from the philosopher, poet, and, at one time, divine. Your readers can draw their own inferences from the above.

As a supplement to what "An Englishman" says in your last, I read, I think, in your pages that a firm at Geneva was making two turbines of 1500 H.P. each, to be used at the Niagara Falls Works. Cannot Americans make turbines?

In the "Yorkshire Weekly Post" for January 7, 1893, are these words:—"The fact that the 'Umbria' is coming back to England with a make-shift shaft, in order to obtain a new one on this side, speaks volumes for the supremacy of English shipbuilding and machinery industry. It is estimated that the cost of a shaft in England would be less than a third of the price in the United States." So, evidently, Americans cannot make shafts at a reasonable rate.

The writer worked for some years in the shops of Messrs. E. Green and Son, Wakefield, and spent a deal of time on experimental work, fitting moulding machinery, making or fixing tools made for their specific work whereby an intelligent labourer, in a short time, could turn out a quantity of work truly wonderful. But neither Messrs. Green nor their men ran about taking every foolish inquirer into their confidence.

It is amusing to see in the columns of a contemporary illustrated articles, copied from the American press, of methods rediscovered by some young Daniel or Solomon that have been in use here for half-a-century. But we on this side the ferry don't care to "sling ink" on such things; we leave that to the American workingman. He can do that if he can do nothing else.

But what about the working-men of America? A friend, a moulder, who has worked in a good many shops in the States, says he never had an American foreman—his last was a Dutchman. Is not the preternaturally intelligent American workingman fit to make a boss of?

As for the question of lathes, referred to by "J. N.," Stockton-on-Tees, that must be left to lathe makers; but this may be said: The writer has fixed for work some thousands of pounds' worth of tools by the best—or one of the best—makers in Manchester, and if any better work is done in this world he would be very glad to see it. No disparagement is meant to any other makers not having had experience with their work. Perhaps American masters are troubled with such men as are referred to in the following extracts from the "Scientific American," published in "Engineering Facts and Figures, 1863":—"We make the unqualified assertion, that not one man in 20 is competent to finish a truly scraped surface. Scraping iron down to a perfect surface is an art by itself, and comparatively little attention, so to speak, has been given to the subject in this country. A finely-finished mirror-like surface on a valve seat or lathe slide is indubitably of great value, and we must, in common justice, give credit to English workmen for great skill in this particular; in general they far excel our own workmen." Evidently the American working-man has not made much progress this last thirty years in doing *good work*, or his advocate would not be undervaluing in others what he can't do himself.

Truly, Americans are fearfully and wonderfully made—inventing, improving, rediscovering. There are no bounds to the wonderful things they have, are, and can do. Indeed, every time the daily paper is opened one expects to find that Europe did

not discover America, but that America discovered Europe. H. G.

Brighouse, Jan. 9.

GAS ENGINE DESIGN.

To the Editor of THE MECHANICAL WORLD.

SIR,—Since the expiration of the Otto gas engine patents a great number of engineers in this country and abroad have set themselves to copy or improve on Dr. Otto's invention.

While engaged upon the design of a new gas engine I found myself at a loss for a reliable formula for the volume of the compression space.

The usual rule is to allow one-third of the volume swept by the piston, but with varying initial and final pressures it can only give very approximate results.

The following, so far as I am aware, is an original formula for calculating the volume of the compression space:—

Let A = The volume swept by the working piston.
B = Absolute pressure before compression.
C = Absolute pressure after compression.
X = Volume of compression space.

$$X = \frac{A \times B}{C - B}.$$

I trust this small contribution will prove useful to some of your numerous readers.

ROBERT W. FIELDWICK.

London, Dec. 31, 1892.

Miscellaneous Items.

The Khedive of Egypt has purchased a Remington typewriter, with which he is greatly pleased.

A new lighthouse is to be erected in the Bristol Channel, at the east bank of the River Usk, by June next.

An offer has been made to light a portion of the town of Singapore for a month, as an experiment, on the Thomson-Houston system, for the sum of £1200. It is probable the offer will be accepted.

Hemp rope contracts if it is wet; a dry rope, 25ft. long, is shortened to 24ft. on being wet. It should not be forgotten that a wet rope has only about one-third of the strength of a dry rope, while if saturated with grease or soap it is weaker still.

A locomotive has been constructed for the New York Central Railroad at the company's shops at Albany. It weighs 120 tons, and has cylinders 19in. by 24in. The total length, including the tender, is 60ft. There are four driving wheels, each 7ft. 3in. in diameter.

A good strong cement can be made of one part, by measure, of powdered clay, one part of dry powdered slaked lime, and one part of powdered asbestos, wet up with water, to which from 1-12 to ⅛ part of its bulk of common molasses has been added. It sets quickly, and has a stony hardness.

An experimental system of luminous buoys has just been laid down in the estuary of the Seine, to mark the limits of the navigable channel up to the embanked portion of the river mouth, which commences at the Risle lighthouse. The lights on the port side going riverward are red, and on the starboard green.

The completion of the Chignecto Ship Railway between the Straits of Northumberland and the Bay of Fundy has been undertaken by a responsible firm of contractors, and the project is believed to be practicable from an engineering point of view. It is expected that the work may be completed in the course of 1893. The expenditure already amounts to more than £800,000.

A postal tramcar is now at work in St. Louis, Missouri, U.S.A.—the pioneer of its kind in the world. It runs on an electric line, making five miles in 35 minutes, and collecting letters as it goes from carriers waiting at a dozen stations. The correspondence is sorted on the way, and the process is so speedy that some letters have even been delivered in 25 minutes from the time of posting.

Ivory is an excellent insulator, but very expensive. A substance has been manufactured in America, with the elements of ivory, as a substitute:—Lime, 100 parts; water, 300 parts; solution of phosphoric acid (density 1·05), 75 parts; chalk, 16 parts; alum, 5 parts; magnesia, 1·5 part; gelatine, 15 parts. Thus tribasic phosphate of lime is obtained, carbonate of lime, magnesia, alum, gelatine, and albumen.

The electric lights now fitted for the London General Omnibus Company are run by a battery weighing about 8lb., placed in a wooden box under one of the seats. The box is provided with two brass spring terminals, which make automatic contact with the battery when it is let down into the box. The lamp is of a special manufacture, and is made as small as possible to allow of it being placed in the centre of the roof, and for the same reason the incandescent lamp is suspended horizontally instead of vertically. By this arrangement a maximum amount of light is obtained and the risk of breakage is avoided.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

POOLE'S GRINDING MACHINE FOR LATHES.—Required, the address of makers of this machine.

FILTRATION.—Will any reader state the best method of filtering 150 gallons of canal water per day for steam-boiler purposes?—T. H. MITCHELL.

FRENCH AND ENGLISH WEIGHTS.—Can any reader inform me of a work converting tables of weight per millimetre into English pounds per metre run?—ANGLO-METRIC.

TWIST DRILL CUTTERS.—Can any reader give me a method of getting the correct thickness and shape of cutter for any diameter of twist drill, straight lip? A drawing will greatly oblige.—J. M. F.

"GRASS" PACKING.—Can any reader supply me with the address of manufacturers of this packing? I have seen it used for the piston and valve rods of L. and N.-W. railway engines.—LOCO.

CORROSION IN GAS ENGINE JACKET.—We have a gas engine, and find, when we draw water out of cylinder jacket, that it is quite muddy with corroded iron. Can anyone inform us how to stop this corrosion?—W. W. AND SONS.

GRINDING VALVES.—Will any reader advise me as to the best means of scouring brass valves and seats to a smooth face? I have tried flour emery, and a fast speed, but as I get at times different mixtures of metal in the valve and seat, I cannot smooth them both together.—W. THOMAS.

LOSSES IN STEEL FURNACES.—Could any reader kindly inform me the average per cent. of actual loss, and the average per cent. of skull, in the charge of a Siemens open-hearth steel furnace working charges of from 30 to 40 tons? And also the percentage of loss in heating slabs and ingots in the Siemens regenerative gas furnace?—J. R. R.

WINDING ENGINE.—What weight would a pair of 36in. cylinder engines by 4½ft. stroke raise from a pit with a spiral drum, commencing at 14ft. and finishing at 18ft. diameter, one side to wind from a depth of 350yds. and the other side from 400yds.; ropes to be 1½in. diameter, boiler pressure 80lb. per square inch, cut-off at ¾ stroke? What weight would the above engines raise from a depth of 280yds., with a flat rope drum, commencing at 12ft. diameter; sizes of ropes 5½in. by ⅜in. (steel)? What would be the rise in inches per yard of a slant whose angle is 26 degrees?—MINER.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

REGULAR SUBSCRIBER.—See page 11.

DOR.—We cannot give you the address.

R. GARNEY.—We are writing our correspondent.

J. MCDOUNELL.—The price of the book is 6s. It may be had from our office.

JOB.—For cast iron 18ft., and for wrought iron 24ft. per minute gives good results. About 3 revolutions per minute would suit your job.

ANXIOUS.—We are much afraid that failing eyesight would prove a bar to your obtaining any of the appointments named. We are sorry we cannot assist you in the matter.

J. BROWNRIDGE.—We think the article referred to was translated from a foreign contemporary. We cannot give you the address of the maker.

STALLED (Loughborough).—You will find full particulars, tables of dimensions, etc., of centre-weight governors, in our issues for June 8 and 22, 1889. You cannot satisfactorily calculate the required power of the governor, and only by experiment can this be ascertained.

J. W.—With a factor of safety of 3, the maximum allowable stress per square inch of section will be 5 tons. Then $\frac{50}{5} = 10$ sq. in. as the required area. Then, according to your value for π, we have $\frac{22}{28} d^2 = 10$, and $d^2 = 12·72$ ∴ $d = 3·56$in.

G. J. J.—Theoretically the same amount of energy would be expended in each case, but the conditions may be such that the guy rope offers the more advantageous method of applying the energy, so that less effort will be required in the latter case. The exact proportion depends upon circumstances, and cannot be stated in the way you suppose.

THREE-THROW PUMP.—A three-throw single-acting pump has barrels 4½in. bore, 14in. stroke, runs at 25 revolutions per minute. It has 3in. delivery 35ft. high; suction pipe, 10ft. high; 230ft. horizontal length, with three bends. Would 3in. suction pipe be large enough to allow pumps to work to their full capacity?—F. C.—*A.*—Find first the number of cubic feet of water required by the pump, which is:—

$$\frac{(4·5)^2 \times 0·7854 \times 14 \times 25 \times 3}{1728}\ 9·66 \text{ cubic ft. per minute, or } 9·66 \times 6·23 = 60·18 \text{ gallons.}$$

Assuming a vacuum of 27ft. of water, 27 − 10 = 17ft. available "head" for forcing water through the suction pipe. Now the diameter of the pipe will be found by the following formula:—

$$D = 1·63 \left(\frac{L}{H} \times \frac{G^2}{C^2}\right)^{\frac{1}{5}}$$

Where D = diameter of pipe in inches.
L = total length of pipe in feet.
H = the effective head of water in feet.
G = gallons per minute passing through pipe.
C = a constant—here about 99.

$$\therefore D = 1·63 \left(\frac{L}{H}\ \frac{G^2}{C^2}\right)^{\frac{1}{5}}$$

$$= 1·63 \times \frac{15·4}{11·1} = 2·26$$

Adding ⅙ diameter of pipe for incrustation, bad joints, etc., the proper diameter by formula under the given and assumed conditions will be 2·63in. You should therefore be perfectly safe in using a 3in. suction pipe. The losses of head due to bends, velocity, etc., are negligible as compared to that due to the length of pipe causing friction.—T. J. B.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

29th December, 1892.

14,124A. COAL CUTTING MACHINES. F Hurd.

19th December, 1892.

23,317 THERMOMETERS and ELECTRICAL CONNECTIONS THEREWITH. G Higton.

23,320 AUTOMATIC ACTION in RAILWAY SIGNALLING. A Hall.

23,321 HEATING LIQUIDS by ELECTRICITY. L B Miller and M W Woods.

23,323 OIL and GAS ENGINES. J H Knight.

23,324 MOULDS and CORES for CASTING. W Drennan and J Dick, jun.

23,332 UTILISATION of ORE SMELTING FURNACE BYE-PRODUCTS. E Nelson.

23,344 INSTRUMENT for USE in DRAWING ANGLES,* F E Wilkins.

23,347 APPARATUS for COOLING, WASHING, and CONDENSING SMOKE. T Critchley and F Hewitt.

23,353 CENTRIFUGAL PUMPS.* H Ludewig.

23,354 PIPE-JOINT or COUPLING. T Holmes and R Williams.

23,355 PIPE COUPLINGS. H Symington.

23,359 CIRCULAR MOULDING MACHINES for WOOD WORKING. T and R Lees.

23,361 WRITING-TELEGRAPHIC INSTRUMENTS.* A Heil.

23,370 INCANDESCENT ELECTRIC LAMPS. W F Taylor and G F Barnes.

23,371 WARMING RAILWAY and OTHER CARRIAGES. T H B Carbis.

23,375 FLEXIBLE METALLIC TUBING. O Imray. (*W H K Bowley*, France.)

23,377 EXPLOSIVES.* O Imray. (*J Storer*, Australia.)

23,383 CYLINDERS and VALVES of STEAM and COMPRESSED-AIR MOTORS. A Holmgren.

23,385 ELECTRICITY METERS. H W Miller.

23,400 APPARATUS for COPYING, REDUCING, or ENLARGING DRAWINGS.* S Price.

23,402 FRICTION GEAR for the TRANSMISSION of POWER. T D Hollick.

23,403 PROCESS for PRODUCING and UTILISING HEAT, and GENERATING, MEASURING, and STORING HEATED GASES, and EMPLOYING the SAME in the TREATMENT of WOOD, ETC. J S Williams.

23,404 TREATING WOOD and OTHER MATERIALS THERMICALLY, THERMOCHEMICALLY, and CHEMICALLY. J S Williams.

23,405 PURIFICATION of the AIR in RAILWAY TUNNELS. J J Hartnett.

20th December, 1892.

23,409 STORAGE BATTERIES.* G A Washburn.

23,412 ANCHORS. J Riley.

23,419 MANUFACTURE of GAS. J Gray.

23,421 SOCKETS for INCANDESCENT ELECTRIC LAMPS.* B J B Mills. (*J Hutchinson*, United States.)

23,422 AUTOMATIC EXPANSION GEAR for MOTIVE-POWER ENGINES. J Cochrane and W Walker.

23,427 SIGNAL LAMP. R P Parkman.

23,429 CABLE TRAMWAYS. E R E Rotter.

23,436 ADJUSTABLE ENAMELLED IRON PLATES for INTERIOR of GAS COOKING STOVES. W B Atkinson.

23,442 AUTOMATIC RAILWAY SIGNALLING. W Grimsley and G Makin.

23,443 DRILLING APPARATUS. E H White and J L Rodgers.

23,453 APPARATUS for REGULATING the SPEED or EXPENDITURE of POWER in VEHICLES PROPELLED by ELECTRICAL ENERGY. C D Abel. (*La Société Anonyme pour le Travail Electrique des Metaux*, France.)

23,460 ELECTRO-MOTORS. H T Barnett.

23,461 ADDING APPARATUS.* C D Judd.

23,466 GOVERNORS. P E Ripley and S Nelson.

23,470 PRODUCTION of MOTIVE POWER. T W Cole.

23,473 BEARING and OTHER FRICTION SURFACES of MACHINERY. E J Bigot.

23,476 PLATING or COATING ALUMINIUM with TIN, ZINC, or LEAD.* R Haddan. (*L Oliven*, Germany.)

23,477 SOLDERING of ALUMINIUM to ALUMINIUM or to OTHER METALS.* R Haddan. (*L Oliven*, Germany.)

23,482 HAND BRACES or TOOLS for INSERTING or WITHDRAWING SCREWS and SCREW HOOKS.* W P Thompson. (*J Lindner*, Germany.)

23,484 APPARATUS for JOINING PIPES and TUBES. H Gibbon and W Tyrer.

23,488 STARTING and STOPPING APPLIANCES for RAILWAY, TRAMWAY, and ROAD VEHICLES. H W B Pring.

23,489 MACHINERY for CUTTING THREADS in SCREW BLANKS.* M Kugel. (*H Weiland*, Germany.)

23,497 APPARATUS for WASHING the GASEOUS PRODUCTS ESCAPING from BOILER FURNACES. E Wardle and J H Evers.

23,498 GENERATION of GAS.* H H Lake. (*A Kimber*, United States.)

23,500 SAFETY VALVES for STEAM ENGINES.* J M Coale.

23,502 INJECTORS. H H Lake. (*The Sherwood Manufacturing Company*, United States.)

23,503 MACHINES for DRYING and FLUXING SHEETS of IRON or STEEL PREPARATORY to TINNING the SAME.* E Norton and J G Hodgson.

23,504 ELEVATED RAILWAYS.* H H Lake. (*J L Meigs*, United States.)

23,505 MACHINES for COVERING WIRE.* H H Lake. (*G O Schneller*, United States.)

23,506 PRESSING and DRAWING of PLASTIC METAL. H H Lake. (*La Société pour la fabrication des Munitions d'Artillerie*, France.)

21st December, 1892.

23,510 VESSELS PROPELLED by SCREWS. F Praunegger and others.

23,511 SHIFTING SPANNERS. T Breakell.

23,514 CRANE for DELIVERING MAIL BAGS to TRAINS in MOTION. R A Ogden.

23,518 DIGESTERS and BOILERS USED in the PREPARATION of WOOD PULP. T Thornley.

23,526 BELT FASTENERS. J Walker.

23,529 SPRING COUPLING.* O Elster and R Lerche.

23,531 PURIFICATION of IRON. E H Saniter.

23,539 DYNAMO-ELECTRIC MACHINERY. W L Spence and D Stewart and Co. Limited.

23,541 APPARATUS for DOVETAILING in WOOD. H Greenwood.

23,543 APPARATUS for PLACING DETONATORS or FOG SIGNALS upon RAILWAY LINES. T Critchley and A Walker.

23,544 "STUFF-GATES" of PAPER-MAKING MACHINES. W H Salmon.

23,560 PICKS HAVING MOVABLE OPERATIVE PARTS. W K Birkinshaw.

23,561 MACHINES for PARING LEATHER. J G W Hartmann and J L Thomson.

23,563 PICKS HAVING MOVABLE OPERATIVE PARTS. W K Birkinshaw and J Mitchell.

23,566 MEANS for PREVENTING COLLISIONS BETWEEN RAILWAY TRAINS. S G Kirk.

23,573 REDUCING VALVES. J E Howard.

23,577 MATERIAL for USE in OBTAINING OXYGEN from ATMOSPHERIC AIR. H Weymersch.

23,579 ELECTRIC INCANDESCENT LAMPS. A Zobel and F Buchmüller.

23,582 CASK-MAKING MACHINERY. H W J Cheffins.

23,587 AUTOMATIC VARIABLE EXPANSION GEAR for STEAM, GAS, or OIL ENGINES. F H Butter.

23,588 METAL DIES. The Phœnix Metal Die and Engineering Company Limited and others.

22nd December, 1892.

23,600 THERMOMETERS and BAROMETERS. L Peroni.

23,601 COMPOUND for the TREATMENT and PURIFICATION of SEWAGE. C A Burghardt.

23,603 COATING or COVERING PAPER WITH ALUMINIUM and its ALLOYS. W Ibbotson.

23,606 TIME-REGISTERING MACHINES. J W Brown and A Heseltine.

23,615 AUTOMATIC PACKINGS for GLANDS, PISTONS, CYLINDERS, and CHAMBERS. J H Turvey and E H Pye.

23,625 FOG SIGNALS. W Pearson.

23,629 APPARATUS for THROWING a LINE ASHORE from a SHIP, or VICE VERSA. T le Poidevin.

23,631 COMBINED MUD RECEIVER and HYDRAULIC LIFT. W B Powell.

23,633 TURNING, SAWING, SCREW-CUTTING, ROUNDING, SHAPING, ETC., MACHINE. J McHardy and others.

23,645 MACHINERY for SAWING and BORING TIMBER. G W Pearce.

23,648 NON-MAGNETIC COMPASSES. J Morton.

23,657 GAS LAMP WITH INCANDESCENT LIGHT.* B Friedl.

23,658 ARMOURING, COVERING, or PROTECTING of ELECTRICAL CABLES. H Edmunds.

23,674 DISTRIBUTING ELECTRICITY. H T Harrison.

23,675 SWITCHES for USE in CONNECTION WITH ELECTRIC GENERATORS. J S Raworth.

23rd December, 1892.

23,678 ELECTRICAL MEASURING INSTRUMENTS. R A Wormell.

23,679 MORTICING and BORING MACHINES. J Wild.

23,680 VOLTAIC CELLS. D G Fitz-Gerald.

23,692 TEE SQUARES, SET SQUARES, and CURVES. H Wildt. (*C Terrott*, Germany.)

23,695 APPARATUS APPLICABLE to ICE CELLS of FREEZING MACHINES. J Siddeley.

23,696 GAS ENGINES. D Clerk and F W Lanchester.

23,700 AUTOMATIC LUBRICATING BEARINGS. J Walker and W Tate.

23,703 HYDRAULIC LIFTS. W R Green.

23,706 COMPOUND and MULTIPLE-EXPANSION FLUID-PRESSURE ENGINES. G M Capell.

23,715 GEAR for HOISTS. H A Mavor and others.

23,719 WIND and AIR DIVIDER for RAILWAY LOCOMOTIVE ENGINES. W Horne.

23,728 FLUID-PRESSURE MOTIVE-POWER APPARATUS. J Priestley.

23,729 CAR AXLE BOXES. H Havell.

23,730 PRESSURE INDICATORS for STEAM ENGINES.* J L Robertson.

23,731 INDUCTION APPARATUS.* The Ruble American Blower and Injector Company and T R Guild.

23,732 PAPER-MAKING MACHINES. R W Moncrieff.

23,749 IMPLEMENT for USE in LEVELLING or ASCERTAINING GRADIENTS. L J J Aubert.

23,750 PLATES for SECONDARY BATTERIES. A Hough.

23,751 APPARATUS for BENDING the MARGINS of PLATES. R H Tweddell and others.

23,752 APPARATUS for REMOVING BOILER SCALE. H Baschy.

23,755 VALVES for ROCK DRILLS. J Rowe.

24th December, 1892.

23,765 GENERATING and CONSUMING GAS from HYDROCARBON or OTHER OIL. F G Birchall.

23,774 OBTAINMENT of the ELECTRIC ARC for LIGHTING and OTHER PURPOSES. R Niewerth.

23,780 DEVICE for CHECKING LEAKAGE of WATER, GAS, or STEAM from PIPES. J May.

23,782 LAGGING for STEAM BOILERS.* G J Clarkson. (*The Mannheimer Gummi-Guttapercha und Asbestfabrik*, Germany.)

23,783 ELECTRIC INCANDESCENT or GLOW LAMP. J Plummer.

23,786 INTERNAL COMBUSTION ENGINES. J Roots.

23,787 FLYING MACHINES. H Middleton.

23,788 ELECTRO-PLATING. S O Cowper-Coles and the London Metallurgical Company Limited.

23,794 HYDRAULIC PRESS CYLINDERS. F Nunns.

23,800 METHOD of COOLING, HEATING, and LUBRICATING CYLINDERS. A R Sennett and J Durie.

23,805 AUTOMATIC ELECTRIC-SWITCHING DEVICE for USE with ARC LAMPS.* R Bombe and F Schuchhardt.

23,808 Apparatus for Producing Steam a a Low Pressure.* C Bourdon.
23,814 Dies or Stamping Machinery to form Deep Conical Shapes from Sheet Metal. W Woolnough.
23,817 Circular Knitting Machines. W J Ford.
23,819 Galloway Boilers. C J Galloway.
23,820 Air - warming Apparatus. M Shillito.
23,822 Wheels. T R Piner.
23,824 Electrode-supporting Combs for Electric Batteries. A J Boult. (*Mannheimer Gummi-Guttapercha und Asbestfabrik*, Germany.)
23,825 Combined Moulding, Planing, and Sawing Machines.* H Skewes.
23,827 Gas Motors. D J Blom.
23,828 Apparatus for use in Fog Signalling on Railways. C H Maxted.
23,835 Apparatus for Obtaining Motive Power. H F McBride.
23,837 Coupling for use in Conjunction with Cylinders, Flasks, and Vessels containing Gases and Fluids under High Pressure. The Manchester Oxygen (Brin's Patent) Company Limited and W M Jackson.
23,838 Heating Liquids to a given Temperature. E and L Broderick.
23,847 Apparatus for Producing a Material to be used as Fuel. J Speir.

27th December, 1892.

23,857 Engraving Glass. H Parker.
23,850 Power - driven Rotary Tipplers or Discharging Coal from Tubs, Trams, and Wagons. W C Blackett.
23,861 Switches and Connections for Electric Circuits. T Cockerill.
23,862 Drive Screw. R Linkletter.
23,869 Automatic Feed-water Regulator for Steam Boilers.* J Thomas.
23,870 Air Propellers or Fans. C Myers.
23,872 Steam Boiler Furnaces. S H Brooks and others.
23,878 Rivet-making Machines. R Kolb.
23,891 Signalling on Railways. T Hollingshead and J Murphy.
23,892 Multiple Telephony and Telegraphy. M Hutin and M Leblanc.
23,896 Ore-roasting Furnaces.* R Pearce.
23,897 Wear Plates for Railway Sleepers.* B Reece.
23,899 Reducing Friction in Propeller and other Shafts.* S Ingersoll and others.
23,900 Triple Scrapers Employed on Tubes of Fuel Economisers. Sir E Green, Bart.
23,901 Mitre Gear Wheels of Fuel Economiser Reversing Mechanism. Sir E Green, Bart.
23,902 Alternate Current Motors. C E L Brown.
23,903 Steam Generators or Boilers. J P Hall.
23,904 Hydraulic Elevators and Lifts.* T F Rowland.
23,906 Incandescent Lamps for Electric Lighting.* F H Prentiss.
23,908 Apparatus for Refrigerating Fluids. E Theisen.
23,913 Machines for Shearing Metal Bars. H H Lake. (*W A McCool*, United States.)
23,914 Sprocket Chains. W A McCool.
23,915 Duplex Drilling Machines. W A McCool.
23,916 Locomotive and other Engines.* J Richards and others.
23,918 Steam Generators.* H H Lake. (*O Jones, H P Ashley, S M Wall, J P Woodson*, and *E J Dobbs*, United States.)

28th December, 1892.

23,921 Prepayment Mechanism of Gas Meters. T Thorp and others.
23,927 Miners' Safety Lamps. J G L McLachlan.
23,930 Apparatus for Steering or Retarding the Motion of Navigable Vessels.* F Tobias.
23,934 Self-adjusting Mechanical Stirrer or Mixer. R E Foxlow.
23,941 Double-acting Cylinder Pump and Valves. J Reid.
23,950 Mechanical Movements. W W Horn. (*J C Githens*, United States.)
23,952 Automatic Couplings for Railway Vehicles. J S Fairfax. (*G Johnston*, South Africa.)
23,960 Cutting Iron Beams. A Klostermann.
23,961 Apparatus for Avoiding Abnormal Consumption of Electric Energy or Overloading of the Main Current when Starting Alternating Current Motors. C E L Brown.
23,962 Rope Couplings. B Kirsch.
23,967 Reflectors for Electric Arc Lamps.* H H Lake. (*C Coerper*, Germany.)
23,971 Nut Locks.* C K Whittier and others.

29th December, 1892.

23,979 Safety Valves for Steam Boilers. E Holt.
23,984 Valves and Cocks. A H Mitchell-Jones and G Spencer.
23,988 Electric Arc Lamps. J Main.
23,989 Centrifugal Speed Governors. K H Kurth and A F Schulze.
23,993 Metallic Tubes for Boilers. S E Howell.
23,999 Signalling Lamps. P and A Graham.
24,008 Electric Lamps. A L Shepard.
24,009 Conduits for Electric Cables. G Crompton and J Chambers.
24,020 Snap Hooks. J Harrison.
24,023 Spiral Creepers or Conveyers. T C Palmer.
24,024 Mechanism for Transforming Rotary into Angular Vibrating Motion. J W Newall.
24,025 New Alloys. S O Cowper-Coles and the London Metallurgical Company Limited.
24,026 Mode of Arranging Steam and other Pipes. H Lea and W H Thornbery, jun.
24,031 Mechanically Placing and Removing Railway Fog Signals. E Woodhead.
23,034 Mechanical Movement. H P Raymond.
24,037 Self-registering Thermometers. F Cossor.

30th December, 1892.

24,047 Aluminium Disc with Index for Aneroid Barometers, Clocks, and Watches. L Cohen.
24,043 Stop and Cut-off Valve for Steam Engines. J A Kirkman.
24,056 Sprinklers for the Extinction of Fire. S Spencer and others.
24,060 Valve Gear for Steam Engines. G P Hoy.
24,061 Plating or Coating Aluminium or Aluminium Alloys.* G Wegner and P Gührs.
24,064 Nut-locking Device. C E Shortt.
24,065 Gas Engines and Motors Propelled thereby.* D Best.
24,067 Signalling on Trains. A Shiels.
24,070 Loading and Conveying of Coal and other Minerals in Mines. H King and R McEwen.
24,071 Application of an Electric Current in the Boiling or Evaporating of Solutions or Liquids. E L C Schiff.
24,078 Boiler Flues. W B Joicey.
24,083 Tubular Boilers. W P Thompson. (*V C J Laurent* and *E Scherding*, France.)
24,084 Regulating the Flow of the Heated Gases in Tubular Boilers. J O O'Brien. (*E Sherding*, France.)
24,088 Dynamo Electric Machines. H H Lake. (*E L Zalinski*, United States.)
24,096 Car Couplings. W W Horn. (*J W Poston*, United States.)
24,098 Apparatus for Starting Non-synchronous Single-phase Alternating Current Motors. C E L Brown.

31st December, 1892.

24,107 Manufacture of Wires, Strip Tape, and Tubes, direct from the Liquid Metals. W J Warren and B Mountain.
24,109 Puddling, Heating, and other Furnaces. J J and T F Meldrum.
24,122 Electroliers, Pendants, Brackets, etc. W Bowker.
24,124 Machine for Trenching, Grooving, and Tenoning. J V Porter.
24,127 Secondary Batteries. F King.
24,128 Machinery for Grinding, Smoothing, and Polishing Glass. W Borrows.
24,131 Signalling on Trains. A Shiels.
24,133 Automatic Safety Hoists. F Virtue.
24,134 Expansion Valves of Steam Engines. T Lees and others.
24,141 Steam Boilers.* P Ferguson and W Y Fleming.
24,142 Multiple Expansion Steam Engines.* P Ferguson and W Y Fleming.
24,146 Railroad Nut-locks. G Olliver.
24,147 Automatic Circuit Closer for Telegraph Keys. C Warren-Bradford.
24,148 Nut Locks.* J W Pugh and L H Austin.
24,149 Bearings of Shafting. H J T Piercy and others.
24,151 Apparatus for the Recovery of Lubricants used in the Cylinders of Steam Engines. C V Bennett.
24,154 Transversely - divided Ship's Boiler.* H Klein.
24,159 Apparatus for Forming the Conductors of Incandescent Electric Lamps. Sir C S Forbes, Bart.
24,161 Tube-stopper for use in Marine or other Boilers. S A Johnson.
24,163 Means for Applying a Locomotive Engine to Operate as a Stationary Engine. J H F Roussel.
24,164 Cocks or Valves for Maintaining the Water Level in Steam Boilers. L Eilertsen.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to Sir H. Reader Lack, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

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The actual sale of THE MECHANICAL WORLD AND METAL TRADES JOURNAL is now equal to, if not greater than, that of all the other recognised Engineering Journals put together. The contents being different to those of the other papers, and the price but a penny, it is not only taken by the firms who subscribe to the high-priced Journals, but by the smaller masters and managers, and those foremen who aim at occupying superior positions—the very men, in fact, who are consulted and have great influence when orders are being placed.

To those advertisers who are being led to believe that the circulation of THE MECHANICAL WORLD is in the North of England, Scotland and Wales only, the Proprietors would state that **11,000** (eleven thousand) copies are disposed of every Thursday over the counter of the London Office alone, to Wholesale Newsvendors there, by whose agency they are distributed throughout the Metropolis, the Southern and Home Counties, Ireland and Abroad.

Some further idea of the real importance of the circulation of THE MECHANICAL WORLD *may be formed from the fact that to print and post a single, ordinary style of circular to as many Engineers, Tool Makers, Steam Users, Managers and Foremen as buy the Journal every week would cost over £60, or more than the price for a good, bold advertisement every other week for more than two years.*

Inquiries from the Provinces should be addressed to the Manchester Office, New Bridge Street, Strangeways; and London communications to 391, Strand.

FRIDAY, JANUARY 20TH, 1893.

Flexible Propeller Shafting.

THE recent failure of the "Umbria's" propeller shaft, together with that of the "City of Paris" not so very many months since, has had the effect of reviving the idea of using flexible shafting for our large liners. When the conditions under which power is transmitted from the engine to the propeller on shipboard are duly considered, it will readily become evident that the bending of the hull of the vessel—due either to climatic conditions, unequal loading of cargo, or the straining in heavy seas—must of necessity entail a considerable loss of power, and at the same time subject the material of the shaft to the most severe stresses, alternately tensile and compressive in character. The frequent failure of propeller shafts cannot, therefore, be a matter of great surprise; and as it is impossible to ensure a rigid and unalterable line of bearings, the only obvious remedy is to adopt some form of flexible shafting, as is now done to a small extent. One of the most ingenious devices brought forward during recent years is the Jerome propeller shaft, which, it may be remembered, consists of a number of hexagonal steel wires lying side by side and welded together at the ends for the coupling connection, while collars for bearings are fixed at intervals on each section. We have no recollection of the estimated cost of constructing such a shaft, but there is little doubt that it would be altogether prohibitive. A flexible method of coupling the several lengths of shafting together appears to promise best, and doubtless some attention will be given to this solution of the difficulty by engineers and shipowners in the near future.

The Three-wire System.

AN action which has engaged the attention of Mr. Justice Romer for several days in the Chancery Division of the High Court of Justice was decided on Saturday. It was brought by Dr. John Hopkinson against the St. James's and Pall Mall Electric Light Company, to restrain an infringement of his patent for improvements in the distribution of electricity on the three-wire system. The only point for decision was the question as to the validity of the plaintiff's patent, for, if valid infringement was not denied. His Lordship, in giving judgment, held that the specification referred solely to the parallel system, and not to the series method. The improvement effected by the plaintiff was over the compound-parallel system. According to this arrangement, the lamps on one side of any parallel could be switched off, and yet leave the lamps on the other side still burning; but the great defect of the system was that the turning off of lamps on one side only of the middle wire increased the brightness of the lamps remaining alight on that side, and diminished the intensity of the illumination of those on the opposite side of the middle wire. Thus the arrangement was a great drawback to the use of the system in private houses. That defect had, however, been overcome by the plaintiff, who joined the intermediate wire to the wire connecting the two dynamos working in series at the generating depôt, and this equalised and rendered steady the brightness of the lamps on both sides, whilst at the same time a considerable economy in the use of copper was effected. His Lordship held that the defendants' objections had failed, that the invention had not been anticipated, and that the patent was valid. He therefore granted to the plaintiff the relief sought by him against the defendants as infringers, with costs on the higher scale, but suspended the injunction for six months. This judgment will, we should imagine, also affect two or three other electric lighting companies in the metropolis, and it is not unlikely that an appeal to a higher court will be made.

Electric Lighting Applications.

THE number of notices of applications to be made to the Board of Trade for powers under the Electric Lighting Acts now diminishes each succeeding year; and, considering the many provisional orders already granted, a falling-off is what might have been expected. Only 32 notices were deposited with the Board of Trade at the end of 1891, and at the close of 1892 this number was reduced to 18. Of these, 6 refer to the metropolis, and the remaining 12 to the provinces. As in former years, local authorities also on this occasion seem determined to obtain and keep in their possession the powers for the supply of the electric light. This is as it should be. It matters little to electrical engineers whether central electric light stations are worked by local authorities, but it is of great import to ratepayers that such undertakings should become municipal undertakings.

The Condition of the Labour Market.

THE Labour Correspondent of the Board of Trade states that the trade returns made by the trade unions for the month of December are generally the worst of the whole year. To the usual seasonal causes—short days and bad weather—which tend so much to restrict employment, are at this period to be added the temporary stoppages of men due to stocktaking, and to the Christmas holidays and New Year holidays. It is also to be expected, especially in a time of bad trade, that in mid-winter all labour not absolutely necessary will be cut down to a minimum. The whole of these causes of trade depression are in operation at present. Only twenty-four strikes have been noted during December, as against forty-four in the previous month. The stoppage in the cotton trade, however, still continues, and but for this the numbers of those involved in disputes would have been exceptionally low. Of twenty-three unions reporting, with a total of 279,361 members, 28,453 are out of work. This is an increase of 5847 upon November. The proportion of unemployed is therefore now 10·2, as compared with 8·27 last month. Eliminating those on strike, there remains a proportion of a little over 8·12 per cent. of unemployed. These figures may be taken as fairly typical of the skilled trades of the country generally. The two unions not included in the above calculations are the Durham and Northumberland Miners' Associations, with an aggregate of 60,000 members, of whom only 26 per cent. are out of work, chiefly from special causes not connected with depression of trade. Coal miners are not affected in the same way as most traders, by dull trade, production being reduced by the working of short time rather than by the discharge of workmen. The collieries are working on the average five days per week, so that the coal trade in that district is fairly well employed. The general proportions of unemployed in the corresponding months of previous years are:—1886, 10 per cent.; 1887, 8·5 per cent.; 1888, 3·1 per cent.; 1889, 1·5 per cent.; 1890, 2·4 per cent.; 1891, 4·37 per cent. The trades now feeling the pinch most are those connected with the shipbuilding and engineering industries, in which employment is very slack indeed. The clothing trades are also very indifferently employed. The building trades also are much worse than for a long time back, the percentage of those out of work being double what it was a year ago. The printing trade seems to have experienced a slight revival, but with this slight exception the general effect of the monthly reports is unsatisfactory. Five unions consider their trades good, seven moderate, twelve bad, and one very bad.

Heating of Tramcars.

THERE is little doubt that the question of providing means in winter time for the heating of tramcars has received more attention abroad than in this country, and for that matter the subject practically forms a parallel with that of warming railway carriages on local lines. In the United States, systems of steam and electric heating have been adopted to a certain extent on some of the tramways—or street railways, as they are generally termed—operated either by steam or electric power, as the case may be. In many instances these lines, considered from the point of view of mileage, are railways to all intents and purposes, and some method of raising the temperature of the interior of the cars may, perhaps, be therefore regarded as necessary. With short lines, however, and with the constantly changing of passengers, it is not easy to understand how travellers would be much, if in any way, benefited by the warming of the cars. The subject has scarcely been drawn attention to in this country; but an agitation on the matter has been set on foot recently, and also some time ago, in Berlin, against the Greater Berlin Tramway Company, which is the largest in that city, and probably throughout Germany. The company employ horse-cars. It appears that an engineering firm some time ago offered to equip with heating apparatus some of the company's cars, and to defray the whole of the expenses; but this proposal was not accepted. Subsequently the company stated that one of their engineers had been sent to the United States to investigate the methods of warming cars there in operation, that as a result of his experience the conclusion had been arrived at that the heating of tramcars was injurious to the health, and that therefore there could be no question of adopting any system on the company's cars. In the meantime—and this only took place towards the end of December—the Berlin Steam Tramway Company have introduced a method of warming their cars, the steam being obtained from the locomotive boiler. As a result, invidious comparisons are the order of the day, and it is said that the first-mentioned company only introduce improvements in "homœopathic doses," which do the passengers little good, but which greatly benefit the shareholders.

Railway Material in Russia.

INFORMATION to hand from St. Petersburg states that the Russian railway managements have hitherto been forbidden to order railway material from abroad, and that the enforcement of this order caused the Russian works to take advantage of the situation by forming syndicates to advance the prices of home manufactures. In order, however, to counteract this movement, the new Minister of Ways and Communications has brought before the Government a proposal to rescind that prohibition and to permit the State and private railways to place orders abroad if they can thereby do so at lower prices than can be secured from Russian firms. It seems, however, that this statement is not quite correct, since railways in that country have been allowed for some time to procure rolling stock from other countries. At any rate, it appears probable that if the proposal of the new Minister is accepted, the result will be mainly to benefit German rather than English firms.

American Steel Castings.

STEEL CASTING appears to be an art which develops but slowly in America; and although progress is being made, the founders do not seem to be very enterprising. Thus the United States Naval Bureau recently sent two designs for engine columns—one a modified form of box girder, the other a form of I beam—to four of the most prominent steel-casting establishments in the country, asking which of the two forms was regarded as the simpler to cast. One firm reported that it could cast either without difficulty; another said that it could cast the I beam, but that the girder was impossible; the third firm offered to make the girder, but not the I beam, saying that the latter was a form that no one could make; while the fourth establishment claimed that both forms were impossible to cast in steel. Comment is, we think, superfluous.

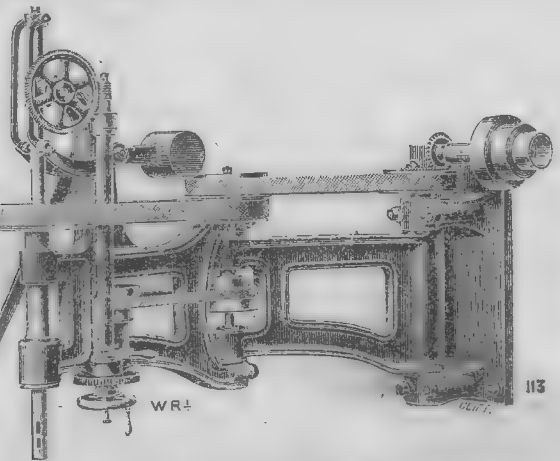
Electric Lighting of Trains.

IT is just announced on good authority that the Northern Railway Company of France are about to equip the whole of their passenger trains with the electric light. The current will be obtained from accumulators carried in the carriages, and the lamps will vary in intensity from 6 to 10C.P. Lamps of 10C.P. will be arranged in the first-class and saloon coaches, of 8C.P. in the second-class carriages, and of 6C.P. in the third-class compartments. Two switches will be fixed at each end of each coach. The object of one of each of these is to put on or extinguish the light from either end, whilst the others are intended, so it is said, to switch on a charging current for replenishing the batteries when exhausted, without the necessity of removing them from the carriages. We should, however,

imagine that it is hardly correct, and that instead of charging separately the cells contained in one coach, the whole of the batteries in the carriages composing the train would be simultaneously recharged. The arrangements will be carried out in such a manner as to allow at any time of the substitution of lighting by oil lamps, if such be desired or necessary, without interfering with the electrical installation.

Wall Radial Drilling Machine.

We have pleasure in directing attention to a new double-hinged wall radial drilling machine, constructed by Messrs. George

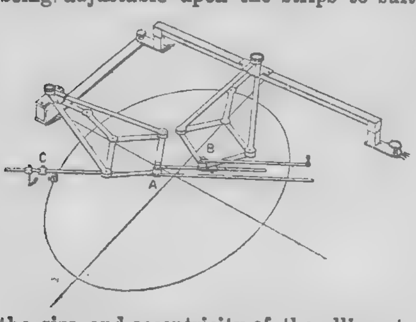


Wall Radial Drilling Machine.

Richards and Co. Limited, Broadheath. It has been designed for economically drilling a number of holes at one setting, and is specially suitable for dealing with large slabs or sheets of metal, such, for example, as those used in electrical switch boards, etc. The machine has a minimum radius of 2ft. and a maximum of 4ft., while it will drill holes up to ¾in. in diameter. As will be seen, the arm is jointed in two places, thus allowing the drill spindle to be readily moved from one position to another, and avoiding the compound adjustment necessary in the ordinary form of radial drill. The spindle is of steel, 1½in. in diameter, and is provided with a variable self-acting feed of 8in. The spindle is balanced, has a disengaging motion for effecting an instantaneous return, and is fitted with a handle for quickly lowering the drill to the work. The machine is driven by a three-speed cone pulley for a 2in. belt, and is complete with overhead driving gear, etc. Further particulars of this exceedingly handy tool may be had from the makers, at the above address.

A Novel Ellipsograph.

The illustration shows a novel though somewhat complex form of ellipsograph, which embodies the well-known Paucellier linkage for producing an exact rectilinear movement from a circular one. The ellipsograph consists of two strips secured firmly at right angles to each other and to the board. Upon these are pins carrying the small ends of the linkages, these pins being adjustable upon the strips to suit



the size and eccentricity of the ellipse to be traced. The inner extremities of the linkages move over the two axes of the ellipse, and the tracing point C is carried by the prolongation of a rod or strip, connecting A and B, as shown. The movement of the apparatus is very smooth, and the whole of the ellipse may be traced at one operation. Experiments made several months ago by the Austrian Society of Engineers and Architects gave very satisfactory results, the errors not exceeding a very small fraction of a millimetre for an ellipse 60 centimetres in the major axis and 40 in the minor.

The Boso Horse Tramway Company, of Boso, Japan, recently decided to construct an electric tramway to replace the present horse tramway.

Recent Boiler Explosions.

(*Continued from page 172, vol. xii.*)

No. 566 refers to the explosion of an economiser at Blackburn, by which one man lost his life. The lower parts of the pipes were wasted where they were connected to the bottom boxes, and it is supposed some of these burst, and the force of the explosion broke the others. The corroding of the tubes externally was no doubt the cause of the explosion, as this is a defect frequently noticed by observers of such economisers. The cold water flowing in at the bottom of these pipes keeps them at such a temperature that the fumes and vapour are condensed upon them, and they consequently rapidly corrode. The corrosion is so superficial and general that it escapes an unpractised eye. In this case, however, the frequent bursting of the pipes proved most conclusively that something was wrong, but still they were worked on until failure occurred. The Commissioners considered the owners to blame, and fined each of them £25.

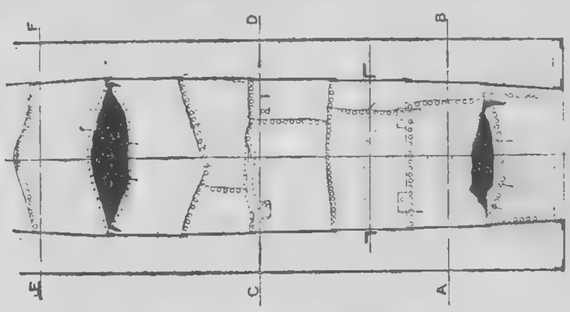
No. 567 refers to the explosion of a vertical boiler which was at work in a yard to which the public had access. It appears that after finishing the day's work the boiler was left apparently quite safe, and although the safety valve was loaded to 60lb. the boiler exploded about one hour after the people left. It was found that the crown of the firebox was forced downward and rent, this being due to over-pressure through the safety valve having been tampered with by some unknown person.

No. 568 refers to an investigation into the bursting of a vertical kier or bone boiler, the bottom of which was not strengthened. It became a question of responsibility. The owner relied on the maker for a boiler capable of withstanding 40lb., but the maker says he never intended it for more than 10lb., while the official surveyor maintained that it was only fit for a water-pressure due to the weight of water it contained. The Commissioners considered the maker to blame for having made and sold an article unsafe for its purpose, as they considered his experience should have told him it was not safe; and if he had not the knowledge and experience, he should not have made it at all. One man was killed and several others injured. Taking into consideration the two conflicting statements of the owner and maker, they fined the latter £15 only.

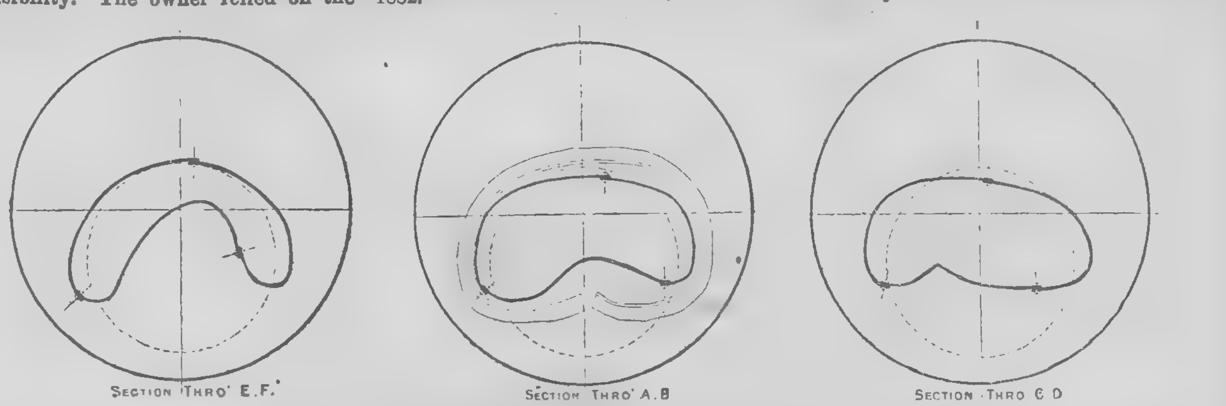
No. 569 is an investigation referring to a boiler of unknown age, which was sold and resold several times, the last time for £5. It was then advertised at £55, sold for £30, but stated to have been sold for £40. The boiler was of the portable locomotive type, the barrel being completely torn to pieces. Fortunately for the broker no one was killed, for the Commissioners considered he had misrepresented the boiler, and fined him £15 15s.

No. 570 refers to the explosion of the casing of a steam stop-valve, probably due to water lodging in the pipes, which were of considerable length. We have often commented on the need for the exercise of care in such cases as these if mishaps are to be avoided, as an accumulation of water in a steam pipe is at all times a dangerous element. Drain pipes should always be fitted, and kept in order.

No. 571 refers to an investigation into the explosion of a Lancashire boiler, which caused great destruction to property, but fortunately hurt no one. The boiler was fed with water containing a large quantity of lime and other deposit, consequently the plates were covered with scale. The grooving escaped the inspector's notice, and the Commissioners considered him to blame. The chief engineer of his company, however, did not consider his inspector had been negligent, knowing that it is impossible to see all parts of a boiler. However, the insurance company was fined £50, which, in our opinion, is one of the most unjust fines that have been inflicted under the Boiler Explosions Act of 1882.



Boiler Explosions.—No. 575.



Boiler Explosions.—No. 575.

No. 572 refers to a minor explosion or failure of a steam pipe, probably due to the pressure of water.

No. 573 refers to an investigation into the explosion of a Cornish boiler with a very weak flue. It was made for 40lb. only; but in spite of the insurance company saying, "These boilers are very weak," and "No. 8 positively dangerous," the firm worked them up to 60lb. until one burst, for which they were fined £50; and had anyone been killed, it would certainly have been a very serious matter for the owner.

No. 574 is a report on the explosion of a kier, killing three men and injuring several others. The exact cause of the explosion is not known, on account of the destruction of the kier. It appears that men were engaged examining a leak at the time of the explosion, and might have been caulking under pressure. The kier was 35 years old, a fact which the Commissioners deprecated, and fined the owners £25.

No. 575 refers to the collapse of a flue in a Cornish boiler, killing one man. The boiler was not insured or inspected, except by their own men, who did not perceive the corrosion becoming serious. However, the flue became so weak that it collapsed, as shown. The company were fined £100, and their consulting engineer £20.

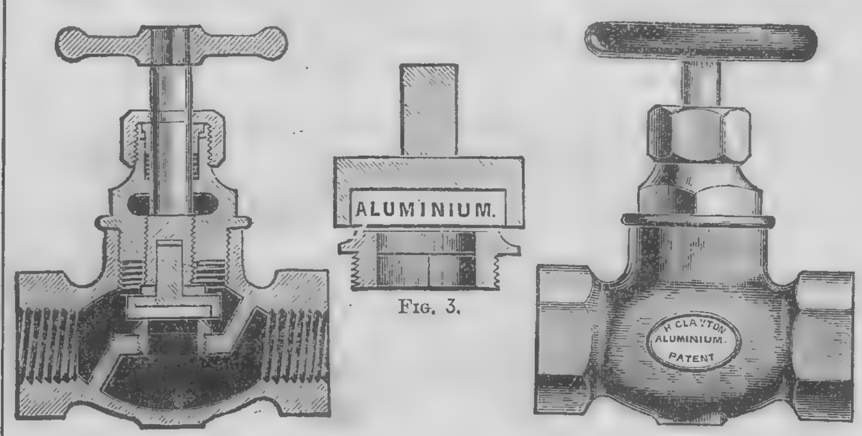


Fig. 1. Clayton's Aluminium-faced Valve. Fig. 2.

Clayton's Aluminium-faced Valve.

The illustrations given herewith show a stop valve fitted with a renewable seat of aluminium, for which several advantages are claimed. The general construction of the valve is shown in Figs. 1 and 2, while Fig. 3 gives an enlarged section of the valve and seat. As will be seen, both valve and seat can be removed in order to re-face or renew them, and this without in any way disturbing the pipe connections or fittings, while the arrangement is such that any unskilled person can readily take out the seat and valve. It is claimed that the aluminium valve and the gun-metal seat form a much better and more durable joint, which holds much tighter than if both the valve and seat were of the same metal. Moreover, the aluminium is not affected by acids or steam generated from soft water. These valves are made to standard sizes; they are used as a combined check and stop valve, and the principle is also applied to water gauges, iron stop valves, etc. Mr. H. Clayton, 115, Thornton-road, Bradford, is the patentee and maker.

The Berlin Electric Railway.

It seems that there is now some prospect of a demonstration of the practicability of the projected underground electric railway in Berlin, to which reference was recently made in these columns. It will be remembered that in August of 1891 the General Electricity Company brought forward a scheme for the construction of a subterranean line to connect the north with the south of Berlin. The ultimate result of the negotiations was that the promoters of the undertaking were informed that before the matter could be seriously considered a short experimental line would have to be laid down in order to show that the project was practicable. We now learn

that the company in question have drawn up a scheme for that purpose. It comprises the establishment of a line 100 metres in length, and capable of forming part of the proposed permanent railway. The authorities have been approached with a view to obtain permission to carry out the enterprise, and it is now hoped that no further obstacles will be placed in the way of bringing the scheme to a successful issue.

Machine Construction.

THE CONSTRUCTION OF MACHINE ELEMENTS.

(*Continued from page* 4.)

2. *Flexible Couplings.*

§ 153.

VARIOUS KINDS OF FLEXIBLE COUPLINGS.

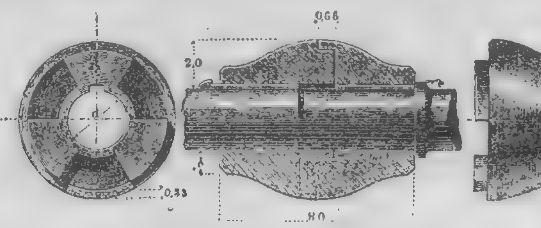
COUPLINGS which permit the shafts to change their positions may be required to meet three different conditions. The motion of the shafts may be :—

(*a*) Lengthwise, or in the direction of the axis.

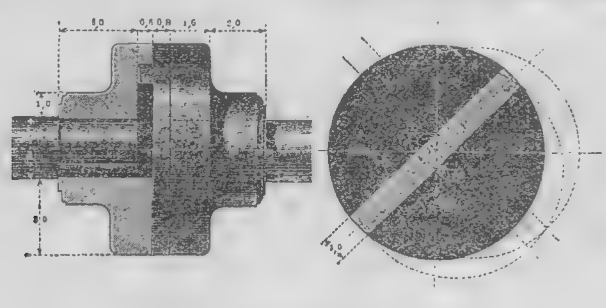
(*b*) Crosswise.

(*c*) Angular, the shafts being inclined to each other.

In some cases two, or even all three, of these conditions may be present. In the first place the axes of the two shafts coincide; in the second case they are parallel to each other; in the third case they intersect; while in the combination of (*b*) and (*c*) the axes pass each other. All these cases occur in actual practice, and meet with useful applications.



MACHINE CONSTRUCTION.—FIG. 430.

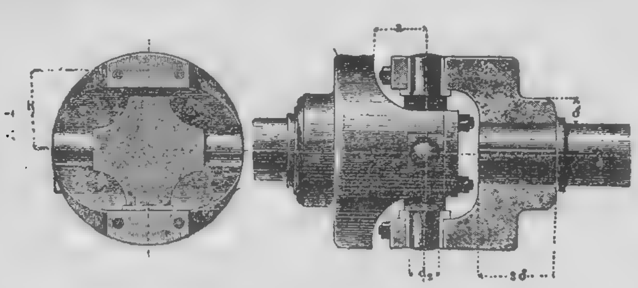


MACHINE CONSTRUCTION.—FIG. 431.

§ 154.

COUPLINGS FOR LENGTHWISE AND PARALLEL MOTIONS.

Endlong motion of the coupled shafts may be provided for by giving various prismatic forms to the parts of the couplings. As an example, Sharp's coupling (Fig. 430) may serve. This permits but slight movement lengthwise, and also a little angular displacement, and is therefore suitable for positions where the bearings cannot be accurately placed. In some recent examples of this form of coupling, one-half is first made and the second cast upon it, and in this case the outer recess is omitted.



MACHINE CONSTRUCTION.—FIG. 432.

In some French screw steamships, in which the screw is arranged to be lifted, one of the shaft couplings is arranged so that sufficient endlong motion may be obtained to permit the end of the shaft to be withdrawn from the hub of the screw.*

For shafts in which the displacement is crosswise, the axes of the shafts remaining parallel, Oldham's coupling (Fig. 431) is most applicable. This consists of two end pieces and one intermediate piece. The latter has a prismatic tongue upon each side, the two being placed at 90° with each other, and fitting into corresponding grooves in the end plates, which latter are keyed on to the shafts. If the two axes of the shafts coincide at O, the tongues and grooves have no sliding action upon each other. If one of the axes is moved parallel to itself, say to P, the middle of the intermediate piece will describe a circle O Q P Q′ of the diameter O P = the distance between the axes, making two revolutions for every revolution of the shafts; the other points of the disc describe cardiode paths. The velocity ratio remains constant.

Another form of coupling for the purpose consists of two cranks connected by a short drag-link to permit the necessary movement. This is frequently used in connecting engine shafts.

§ 155.

JOINTED COUPLINGS.

The best known of all the flexible couplings is the Universal joint, known also as Hooke's coupling, and also as Cardan's coupling.† This form of coupling permits the connection of inclined axles within certain limits. It consists broadly of two end pieces and a middle piece, the latter containing two pairs of journals placed at right angles with each other in the form of a cross, each pair fitting into journals on one and the other of the end pieces respectively.

The rate of transmission of motion is not uniform, and is dependent upon the axle of inclination α of the two shafts, the angular rotations ω and ω_1 of the driving and driven shafts being expressed in the following ratio :—

$$\frac{\tan \omega_1}{\tan \omega} = \cos \alpha \text{ ....(143)}$$

which gives a periodical variation whose period is 180°. The table on next column gives the values of ω_1 for successive values of ω, for various angles α.

For small values of α the variation is unimportant. For the angular velocities α, and ω_1, we have the relation :

$$\frac{\omega_1}{\omega} = \frac{\cos \alpha}{1 - \sin^2 \sin \omega^2 \alpha} \text{ ...... (144)}$$

which gives a maximum $\frac{1}{\cos \alpha}$ and a minimum $\cos \alpha$. These variations in velocity may be neglected when the moving masses are inconsiderable and the angle α is small.‡

* Among various interesting examples of such couplings may be mentioned those described in Armengand's "Vignole des Mecaniciens," Paris, 1863, plate 9; also Ledieu. App. à vapeur de navigation, Paris, 1862, and Ortolan, Mach. à vapeur marines, Paris, 1859.

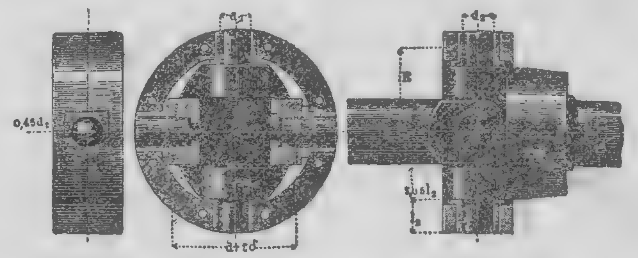
† If not the original inventor of the Universal joint, the Italian, Cardan, was the first to describe it (1501—1576), and the Englishman, Hooke (1635—1702), first applied it for the transmission of rotary motion.

‡ In the table the values of ω are so placed that when $\omega = O$, the cross journals of the coupling lie in the plane of the shafts.

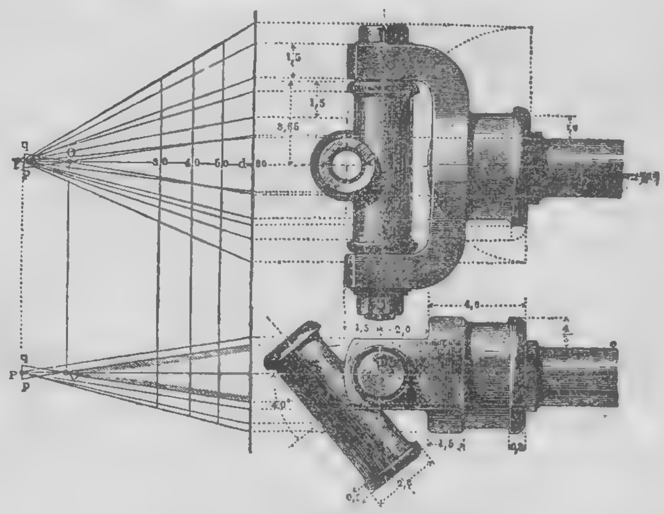
The detailed construction of the coupling admits of great variations. Fig. 432 shows a form with cast-iron end pieces and wrought-iron middle piece. The relation $\frac{R}{d}$ is varied also. The journal diameter d_2 is determined by the methods already given, and from the moment of rotation (P R) the journal pressure P_2

ω	$\alpha = 10°$	20°	30°	40°
30°	29° 38′	28° 29′	26° 34′	23° 51′
45°	44° 34′	43° 12′	40° 54′	37° 27′
60°	59° 34′	58° 26′	56° 22′	53° 04′
90°	90°	90°	90°	90°
120°	120° 26′	121° 31′	123° 38′	126° 56′
135°	135° 26′	136° 48′	139° 06′	142° 33′
150°	150° 22′	151° 31′	153° 26′	156° 01′
180°	180°	180°	180°	180°

may be taken with sufficient accuracy as $= \frac{\frac{1}{2} P R}{R}$. The distance a should be made greater as the angle α is increased. The joints in the boxes should be made in the plane of the shafts, not at right angles to them, in order to provide for the wear.



MACHINE CONSTRUCTION.—FIG. 433.

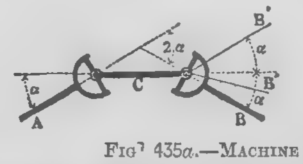


MACHINE CONSTRUCTION.—FIG. 434.

Universal joints are used to good advantage in screw propeller shafts in order to provide for the flexure due to the elasticity of the hull of the vessel. In such cases two universal joints are used on a shaft. A coupling for such service is shown in Fig. 433. Here all these pieces are forgings, one end piece being forged solid with the shaft. The middle piece is formed of a double ring, the bearings being held between the two parts, while the journals are secured to the end pieces. No provision is made for taking up the wear upon the journal boxes, as the angle α is so small that the wear is very slight. The length l_2 of the journals need not be great, about 1 to 1 25 d_2, and since R can be kept small, the dimensions of the entire coupling may be kept within reasonable limits.

Another form of universal joint is shown in Fig. 434. Here the cross journals are made in the form of through bolts, passing through both end and middle pieces. This requires a slight modification in the form, since the axes of the

a.



b.

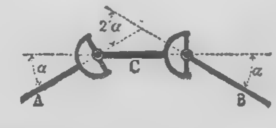


FIG. 435*a*.—MACHINE CONSTRUCTION.—FIG. 435*b*.

two bolts cannot intersect each other. A slight error in motion follows, causing a very small endlong motion with each revolution in the coupled shafts, but this is generally insignificant. This form is suitable for agricultural machinery, horse powers, etc. In the illustration a proportional scale is given. The modulus is as before : $\delta = \frac{1}{3} d + \frac{3}{16}$in. The pole P is therefore taken, so that $\frac{1}{3} d +$ ·s in. $= o$, or so that $d = -\frac{9}{16}$in.

The irregularity in motion shown in formula (144) is generally of little consequence, and need not be considered except in cases requiring geometrical exactness, as in the connections for large tower clocks, or in cases where large masses are drawn at high velocities, as in threshing machines. The variation can be obviated by the use of a double universal joint, which consists of two simple couplings. If (Fig. 435*a*) the driving shaft A is coupled to B by means of a short intermediate shaft C, the connections being made by two similar couplings of the same angles, then the motion of A will be transmitted to B without variation. In this case the driven shaft may be given several positions with regard to A, being placed at B, making the angle 2 α, or at B′, parallel to A, or at B″ on the surface of a cone of half the angle α, which is made with the intermediate axis C. The two universal joints are similarly placed when the cross axes belonging respectively to A and B lie in the same plane as the shaft C at the same time. In the positions B and B′ all three shafts lie in the same plane, but not in position B″. In the last case A and B intersect.

If the cross axes are not placed similarly, but, for example, at 90°, as in Fig. 435*b*, the variations of motion are increased, and we have :—$\tan \omega_1 = \tan \omega \cos^2 \alpha$, in which ω and ω_1 stand for A and B. If $\alpha = 30°$, we have for $\omega = 45°$, $\tan \omega_1 = (\frac{1}{2}\sqrt{3})^2 = 0·75$; hence $\omega_1 = 36° 54'$, instead of 40° 54′, as in the table above.

(*To be continued.*)

Manchester Association of Engineers.

A MEETING of this association—the first of the new year—was held on Saturday night at the Grand Hotel, Mr. T. Daniels, president, in the chair. After some formal business, the president delivered his inaugural address. He said that at the present time England was being met at all points (except in India) with American, Belgian, and German competitors, and this competition was rendered all the more severe owing to the great difference in the number of hours worked and wages paid. It was a mystery to him, however, why the well-educated Continental artisans should have to work longer hours, and for considerably less wages, in order to compete with the uneducated British workman. It was undoubtedly a question for future consideration; but our prominent labour leaders should try to get the Continental artisans' working hours on a par with those in England before we reduce our present working time. Education upon the Continents

artisan had a contrary effect to what it had upon the British workman, as with the latter the more he was educated the more he insisted upon shorter hours and larger wages. Speaking of the relations between capital and labour, he said that if they were to be handicapped with Acts of Parliament at every turn, the best plan would be for the Government to take over the whole business and carry on the trade of the country. In view of the great interests represented by capital and labour, it seemed almost impossible to find the leaven that would make them work smoothly and profitably together. A portion of the community were under the impression that co-operation was the leaven. Co-operation undoubtedly might prosper with able management, as the members simply dealt with themselves; and as long as the co-operators manufacture and sell what the members eat, drink, and wear, all might be satisfactory. If, however, the co-operators took orders in the open market for boilers, locomotives, or machines, the result might be very different. Then again, not a few people were of opinion that profit-sharing would solve the problem; but he thought labour would look with some suspicion upon this method. Men would hardly believe that capital would allow them to know all the profit which was made. Suppose there was a loss on the year's working: would the men care to have their wages reduced to make up the deficiency? He thought not. It was exceedingly difficult to make a workman understand that you occasionally took work at a loss. To meet the wages difficulty, a better plan, in his opinion, would be to give workmen and officials a bonus of so much per cent. on the work turned out, without any reference to the question of profit or loss. If it could be arranged that workmen might have shares allotted to them suitable to their means, this leaven of self-interest, as small capitalists, would work to prevent strikes, and even if one occurred it would not be prolonged to any extent. Many manufacturers now gave their officials an interest in the concern, and this tended to the advantage of the capitalist. Why not extend the privilege to the leading workers? and then men, officials, and employers would all pull together for the common good, and the best results would be obtained. In what manner and by what means could antagonistic views be brought together for the good of the whole? By boards of conciliation, or district trade councils, composed of men representing capital and labour. In this respect there seemed now to be a grand opportunity for one of our capitalists and employers to establish such a board in the Manchester district, and thereby set an example to other districts—to get all the capitalists to unite and select their representatives. Labour was already united, and could soon have their men ready. Speaking of the state of trade in Manchester, he said he was under the impression that during the past 20 years Manchester had not made the same progress as, say, Leeds or Glasgow. In the locomotive trade, for example, the last return indicated that the number of men employed in the Glasgow workshops was 5511, while the number at present in Manchester was only 1500. Why had this city, which 20 years since held the premier position in locomotive building, been relegated to such a position? One could hardly believe it, because, as far as his memory went, no disputes or strikes had occurred to cause such a great difference. Practically, everything in that department of engineering had gone on smoothly. Certainly there was the boilermakers' strike in 1878, but that did not apparently affect the local boilermakers. Fortunately, however, at the present time, consequent upon the boilermakers' wages being more uniform, Lancashire makers could hold their own with the Scotchmen in that department. In the tool trade, notwithstanding the ingenuity and good workmanship displayed by our machine tool makers, a considerable amount of work that 20 years ago came to Manchester had found its way into Yorkshire. Locomotives, machine tools, and general engineering might be considered open work. They were competed for in the open, and went to the cheapest market. What, therefore, had saved Manchester, and kept it in the not unenviable position which she even now occupied? The answer was found in the inventions of Whitworth, of the manufactures of Gresham and Craven, of the gas engine by Messrs. Crossley Brothers, and of the specialities of Messrs. Mather and Platt, the total number of men employed by these firms being, on an average, about 4000. Speaking of his own branch of the engineering trade, he said that in 1891 we exported engines, machinery, and millwork to the amount of £15,817,515. This amount had been much decreased for the year 1892. At the present moment they had to contend with severe competition, and were unable to make the work pay at the present rate of wages for 53 hours per week. This being the case, what would be the result if swaggering labour leaders so mixed up politics and labour as to get an Act passed to limit a day's work to eight hours? In his opinion it would result in the loss of the greater part of our trade, works would have to be closed, and thousands of hands thrown out of employment.

At the close a hearty vote of thanks was given to the president for his address.

London Association of Foremen Engineers and Draughtsmen.

THE annual general meeting of this association was held on Saturday, the 7th inst., at 7 p.m., in the Cannon-street Hotel, when the president (Mr. F. J. Garnish) and the vice-president (Mr. Jas. Brown) occupied the chairs.

After the usual business had been got through, the president delivered his annual address before retiring from the chair. He had chosen for his title "Progress," and stated his opinion that the great progress made in science and manufacture was largely due to such associations, where the latest information and experience of those most fitted to give them are brought forward. He referred to the satisfactory progress made by the association during the past year, and gave an outline of the proceedings, and noticed the papers which had been read at the monthly meetings. He drew attention to the progress which had been made in various departments of engineering recently, and pointed out that there was still room for improvement. He especially mentioned the desirability of having some simple, reliable method of warning those in charge when ships approached the shore or got into shallow water, and also to some addition to the present system of railway signalling by which it would be impossible to allow a train to pass on to any given section of line so long as another train was on it. He incidentally stated that the rate of our recent progress was clearly shown by the Patent Office records, as for several years past the number of applications for patents have increased at about the rate of 1000 per annum, until in the past year they reached the enormous total of 24,000. He considered that much of the mental advance in all classes is due to the mechanical arts, which do well by unconscious machinery what was once done badly by human hands, thus leaving the mind free to work in more profitable directions, that which once required continual skill and watching being now left to the care of machinery, that is much more certain than the old and laborious system of hand work.

Mr. Wm. S. Coates was elected president for the present year, and Mr. Brown was re-elected vice-president. Votes of thanks having been passed to the retiring officers for their services, the meeting closed.

Shipbuilding Notes.

Messrs. Napier, Shanks and Bell, Yoker, have received an order to build a steam yacht 210ft. in length.

Messrs. Laird and Co., of Glasgow, have ordered a screw steamer for their trans-Channel service from Messrs. D. and W. Henderson, Partick.

It is reported that Messrs. Scott and Co., shipbuilders, Greenock, have been instructed to build four steel barges, each 160ft. long and extensive beam, for service in the East. They will be shipped in sections.

The drawings and plans for a new first-class battleship, to be constructed in Chatham Dockyard, are now being prepared at Whitehall, under the direction of the Constructive Department. The new vessel will be commenced forthwith, and is intended to be completed during the approaching financial year.

The battleships launched for the Royal Navy in 1892 were the "Ramillies," "Repulse," "Revenge," "Resolution," "Royal Oak," "Barfleur," and "Centurion"; the first-class cruisers were the "Crescent," "Gibraltar," "Grafton," "St. George," and "Theseus"; the second-class cruisers were the "Æolus," "Bonaventure," and "Scylla"; and the torpedo gun-vessels were the "Circe," "Hebe," "Leda," "Jason," "Alarm," "Jaseur," "Renard," "Niger," and "Onyx." The aggregate tonnage displacement of these vessels is 148,200; the aggregate indicated horse-power 209,500. The armament of the ships launched in 1892 will consist of 20 13·5in., eight 10in., nine 9·2in., 108 6in., 56 4·7in., 180 6-pounders, 127 3-pounders, and 101 machine guns, or 609 guns in all; and of 108 torpedo ejectors. The total complements of the new vessels of the year will be about 8800 officers and men.

The Value of the Steam Jacket.

(*Concluded from page 5.*)

Experiment No. 49: Two non-condensing trials with and without steam in jackets.—The trials were made at about full speed. With the exception that in this case there was no vacuum in the condenser, all the conditions were the same as those for the first two trials of Experiment No. 47.

The trial without steam in any of the jackets lasted for 38¾ minutes. The consumption of feed-water was at the rate of 62·64lb. per indicated horse-power per hour.

The trial with steam in all the jackets lasted for 44 minutes. The consumption of feed-water, including jacket-water, was at the rate of 35·69lb. per indicated horse-power per hour, showing a saving in feed-water of 62·64 − 35·69 = 26·95lb. per indicated horse-power per hour, or a decrease of 43 per cent. due to the action of steam as compared with air in the four jackets. The mean temperature of the internal part of the cylinder walls was 44° higher with steam in the jackets than without. The total condensed water from the jackets was as follows:—

Jacket.	Condensed Water per I.H.P. per Hour.
Body jacket, inner wall ..	0·75lb.
„ outer wall ..	0·81lb.
Top-end jacket	0·22lb.
Bottom-end jacket	0·53lb.
Valve-chest jacket	0·25lb.
Total jacket-water	2·56lb.

The total quantity of steam condensed in the jackets was therefore 2·56lb. per indicated horse-power per hour, which is equivalent to 7·17 per cent. of the feed-water. Thus for every lb. of steam condensed in the jackets there was a net saving in feed-water consumption of 10·5lb.

Comparing these two non-condensing trials with the first two trials in Experiment No. 47, which were condensing and had all the other conditions the same, the useful effect of the jackets was increased from 31·1 per cent. to 43 per cent. when the engine was worked without a vacuum, thus:—

Engine Working.	Saving due to Steam Jackets. Per I.H.P. per Hour.	Per Cent.
Condensing	12·84lb.	31·1
Non-condensing	26·95lb.	43

Experiment No. 50: Twelve trials with and without steam in the jackets, at various ratios of expansion.—These trials were made condensing, at a speed of about 218 revolutions per minute, and with a steam pressure of about 50lb. per square inch above the atmosphere. The trials were made in pairs, jacketed and unjacketed, at six different degrees of cut-off—$\frac{1}{16}$, $\frac{1}{12}$, $\frac{1}{8}$, $\frac{3}{16}$, $\frac{5}{16}$, and $\frac{1}{2}$-stroke—all the other conditions remaining as far as possible the same.

With the greatest number of expansions, 6·8 at $\frac{1}{16}$ cut-off, the saving due to the jackets was 40·4 per cent., while with the smallest number of expansions, 1·8 at $\frac{1}{2}$, cut-off, the saving was only 23·1 per cent.; or, speaking generally, the saving in steam consumption due to the use of steam-jackets increases with the number of expansions.

The great difference in the temperatures of the cylinder walls with and without steam in the jackets is clearly noticeable. This difference decreases considerably as the number of expansions decreases. The effect of steam-jacketing on the dryness-fraction of the steam in the cylinder, both at cut-off and at release, is distinctly marked.

At a speed of about 220 revolutions per minute, the cut-off giving a minimum steam consumption with steam in jackets was found to be at $\frac{1}{8}$ of the stroke, equal to 4·8 expansions. The consumption of feed-water, including jacket-water, per indicated horse-power per hour in this case was 25·2lb., and the dryness-fraction of the steam in the cylinder at release was 96·6 per cent. At the same speed, without steam in the jackets, the best cut-off was found to be at $\frac{5}{16}$ of the stroke, equal to 2·6 expansions. Here the steam used was 38·7lb. per indicated horse-power per hour, and the dryness-fraction of the steam in the cylinder at release was 73·9 per cent.

It is observed that the steam consumption tends to follow the dryness-fraction at release; the steam consumption increasing with the wetness of the steam. The drier the steam at release, the greater is the economy, the maximum economy being obtained with the steam practically dry at release.

Experiment No. 51: To determine the effects of the steam jacket on the speed of the engine and temperature of the cylinder walls, etc.—Throughout this experiment the condenser was kept in action, steam was cut off at 3-16ths, and the steam pressure and load on the brake were kept constant. Only the body jacket was used, steam being shut off from the other three. The object of the experiment was to determine the effects on the speed of the engine and the temperature of the walls, etc., when steam was admitted to the body jacket and shut off from it again without stopping the engine. Starting at 11-30 a.m., after normal working conditions had been reached, the engine was worked for eleven minutes without steam in the jacket, and allowed to attain a constant speed of 140 revolutions per minute and a constant temperature of the cylinder, after which, at 11-41 a.m., steam was admitted to the jacket without stopping the engine. Six minutes afterwards, at 11-47 a.m., when the engine had acquired an increased speed of 265 revolutions per minute and the temperatures had also again become constant, steam was shut off from the jacket, with the result that the speed and temperatures gradually decreased. Fifty minutes afterwards, at 12-37 p.m., the speed was found to have fallen to 190 revolutions per minute; and had the experiment been continued long enough, it would have decreased to 140 revolutions per minute, as at the commencement. Every two minutes throughout the experiment observations were made of speed, jacket pressure, and the various principal temperatures. From the results it is seen that the temperatures in the cylinder quickly increased after steam was admitted to the jacket; and on the contrary they decreased, though less quickly, after the steam supply was shut off, the only heat then available being that shut into the jacket space and that remaining in the metal of the cylinder walls. The speed of the engine decreased considerably as this heat was gradually exhausted.

Superheating.—Subsequent experiments have been carried out, using slightly superheated steam both in the jackets and in the cylinder. With only from 35° to 58° F. of superheating, and using this steam in all four jackets as well as in the cylinder, there was an economy of about 26 per cent. due to the jackets, in comparison with the result obtained when using the same steam in the cylinder alone and shutting off the jackets. The engine was working condensing a 1-16th cut-off, and at a speed of 200 revolutions per minute. The increase in temperature of the cylinder walls when the jackets were in use was about 50° F.

Conclusions.—With the same quality and temperature of steam, in these experiments, the hotter walls yielded the better results. With walls of the same temperature, the dryer and hotter the steam the greater was the economy. The best result with all the jackets in use was obtained with 1-8th cut-off, or 4·8 expansions; the consumption was 25·2lb. of steam per indicated horse-power per hour, including jacket-water; and the dryness fraction at release was 96·6 per cent., showing that in this case the exhaust steam was practically dry and neither superheated nor wet.

APPENDIX.—SUGGESTIONS FOR FUTURE EXPERIMENTS ON THE STEAM JACKET.

The date, place, and duration of each experiment should be recorded, and the names of the experimenters.

In the description of the engine it should be stated whether it is single-cylinder, compound, or triple-expansion, horizontal or vertical, condensing or non-condensing, and the diameters and strokes of the cylinders should be given, and the kind of valves mentioned.

The following particulars should also be furnished:—Manner in which each cylinder and receiver is jacketed, giving dimensions for enabling the jacketed and unjacketed areas of the internal surfaces of each to be calculated; particulars as to how the steam is supplied to the jackets, and how they are drained, giving the lengths and diameters of the supply pipes. Details of how the outer walls of the jackets are protected.

A sufficient number of measuring tanks, etc., should be provided, to allow the feed water and the discharges from the jackets, drain pipes, etc., to be measured separately.

Each body jacket should be provided with a pressure gauge; and also with two cocks, one at the highest point and the other at the lowest, to test for air, steam, or water, during the experiments. Each of the other jackets should also be provided with an air cock at its highest point, so that if air is present it may be allowed to escape from time to time.

A separate indicator should be used for each end of each cylinder, and the engine should be fitted with a speed counter.

Before the experiments commence the valves and pistons should be tested for leakage, by blocking the engines in different positions and opening the indicator cocks.

The body jackets should also be tested for leakage at the usual steam pressures, the pistons and cylinder covers being removed if possible, or by steam being admitted to the jackets and the indicator

cocks opened before steam is admitted to the cylinder.

The quantity of steam condensed in the jackets when the engine is standing should be ascertained by admitting steam to them at the usual pressures and measuring the discharge from each.

Throughout the whole of the experiments the quantities of feed water, circulating or injection water, jacket water, drain water leakage from valves or stuffing boxes, and water from the steam separator, should be measured. The discharge from each jacket should be taken separately, and the temperatures of the feed water and of the circulating or injection water should be noted.

The readings of the speed counter and the pressure gauges should be all noted at regular intervals. Sets of indicator diagrams should be taken at regular intervals, each set consisting of a diagram from each end of each cylinder, taken as far as practicable simultaneously. The highest and lowest pressure in each cylinder should be ascertained from the diagrams and recorded, for allowing the range of temperature in each cylinder to be calculated. The mean effective pressures and ratio of expansion should be calculated from the diagrams and recorded, and the indicated horse-powers worked out. The percentage of moisture in the steam should be recorded if known. The kind of lubricant used for the cylinders should be stated, and the same quantity per hour should as far as possible be supplied during comparative trials with and without steam in the jackets.

Hull and District Institution of Engineers and Naval Architects.

On the 9th inst., the usual monthly meeting was held at the Institution Rooms, Bond-street. At the conclusion of the usual business, a paper on "The Necessity of and Means for Maintaining the Purity of the Water in Marine Boilers," was read by Mr. J. B. Edmiston, M.I.M.E., M.I.N.A., etc., of Liverpool.

He commenced his paper by dealing with the general causes of corrosion in marine boilers, such as rusting, and the various galvanic, electric, and chemical actions, etc., and the efforts that have been made to minimise corrosion by purifying the water by the use of solvent compositions and different forms of zinc. Coming to the subject of filtration, the lecturer thought this the means most likely to be effective in keeping boilers in a state of absolute cleanliness. Of course there were certain difficulties to be overcome, but he thought these were successfully dealt with in the designs and models he submitted.

The paper was well illustrated by drawings and models, and also by samples of deposits and filter cloths taken out of the filters after use.

The following gentlemen took part in the discussion:—Messrs. W. B. Dixon, J. Jamieson, M. Stirling, H. F. Fowney, R. Innes, G. H. Strong, J. Innes, W. Harris, J. Spear, and F. H. Pearson.

A hearty vote of thanks was accorded to Mr. Edmiston, on the motion of Mr. Spear, seconded by Mr. Pearson, for his valuable paper.

Peat as Fuel.

(Continued from page 266, vol. xii.)

Hodgson, of Ireland, adopted a plan for securing a cheap and abundant supply of dried and powdered peat by passing a very light harrow over the surface of the bog and thus breaking up a thin layer. After a few hours' exposure to the air, for draining and partial drying, this is removed by scraping, and a supply of powdered peat much drier than the general mass may thus be obtained. It is then heaped in embankments and dried by being spread on iron plates warmed by the waste steam from the compressing engine. The pressing machine consists of "a horizontal reciprocating ram," said to be capable of turning out 1500lb. of compressed peat per hour equal in density to coal.

The process patented by Gwynne and Co. differs from Hodgson's in depriving the raw peat of a large part of its moisture by subjecting it to the action of a centrifugal machine, after which it is ground to powder and passed through a series of cylinders revolving in a heated chamber, where the remaining moisture is got rid of. It is then compressed at a temperature of 180°, at which temperature the tarry properties of the turf are just sufficiently developed to form a good cementing compound, and the result is a dense and very pure fuel.

In 1856, Exter, of Bavaria, carried into operation on an extensive scale under the Bavarian Government a method of preparing peat fuel which in its initial stages is practically identical with Hodgson's, described above. After scraping together the broken and partially dry peat, it is, if necessary, further pulverised by passing it through toothed rollers. It is then introduced into a complicated drying oven, along the various floors or chambers of which it is moved by spiral conveyors exposed to a temperature of from 120° to 140° F. The peat is then subjected to the action of a powerful eccentric press and formed into blocks which occupy about one-fourth the space of the same weight before pressing, the cubic foot weighing about 72lb. In 1857 the cost of peat produced in this way was estimated at about 6 cents per 100lb., and was of excellent quality, being used exclusively for firing locomotives. Exter's process was adopted with some modifications in Hungary and Hanover, in the latter country unsuccessfully, owing to the fact that it is suited only to the better kinds of peat.

Elsberg, of New York, invented a modification of Exter's method by which the peat, air-dried as in Exter's process, is further broken in a cylindrical pug-mill, and at the same time subjected to a current of steam admitted through a pipe and jacket surrounding the cylinder. The steamed peat is then condensed by a pair of presses fed directly from the mill. In this way the complicated drying oven of Exter is dispensed with.

The "University Magazine" claims for M. Challeton de Brughat, a French gentleman, the honour of having invented this process, which it describes as one in which thoroughly decomposed peat is well puddled together with a due admixture of water, and then passed through a very fine sieve, which separates the minute carbonaceous particles. These when submitted to a process of drying are found to possess an adhesive affinity, the effect of which is to combine them together in one solid mass analogous in density and hardness to ordinary coal. A modification of his method was adopted by the Irish Peat Fuel Company, as follows:—The raw peat, after having been properly macerated in a powerful disintegrating mill, cleansed from impurities and reduced to pulp, is conducted into reservoirs 160ft. long by 42ft. wide and 18in. high. The sides of these reservoirs are made of a kind of basket work, and the water in which the peat particles are held in suspension flows rapidly away on all sides, acted on by the force of subsidence. When the pulp has acquired sufficient consistency, its surface is marked out by a cutter into regular brick-like shapes, which facilitates the process of drying so much that in 24 hours afterwards they are generally dry and firm enough to bear handling. They are then removed and placed on light frames, where they remain for a month, when they are completely dry and ready for delivery. In May, 1873, a quantity of De Brughat's peat coal was tested on the North London Railway, a trial run being made from Broad-street Station to Kew, a distance of 29 train miles, with a train consisting of an engine and 9 carriages. The results gave the highest satisfaction. The steam was abundant and the engine worked up to 165lb. pressure. The consumption of fuel for the total run was 48·3lb. per mile, leaving off with a large clear fire; there was no clinker in the bars and but a small amount of *débris* in the smoke-box. The average consumption of the best coal by the Kew and Richmond passenger train for the same number of carriages is 32lb. per mile. One and a quarter tons of De Brughat's peat coal are said to be equal to one ton of the best English coal for ordinary steam purposes, while for household use and for furnaces having little draught, and with the firebars close together, one ton of peat is equal to the same quantity of pit coal. As to the commercial aspect, it is stated that De Brughat's own manufacturing experience, extending over many years, proved beyond a doubt the remunerative character of manufacturing peat coal. The total cost of producing this article on a large scale at De Brughat's works is 6s. per ton, while be gets for it on the spot 28s. per ton, and from 33s. 6d. to 36s. per ton at Paris, at which price the demand is active for all he can supply. The same gentleman also manufactures peat charcoal at a profit of 300 per cent. in actual operations. The charcoal is stated to cost practically nothing to manufacture, owing to the value of the other products evolved in the process; and it sells at £6 to £6 8s. per ton in Paris, wood charcoal bringing between £5 and £6 per ton.

The Clayton method is simply to cut the peat into fragments in its raw, moist state, drain off as much of the water as will freely run away, then masticate the fibres and whole mass of peat together in a machine until it becomes difficult to distinguish any ligneous fibre distinct from the humus in which it is so entirely mixed. The pulped peat is forced out through orifices in the end of a cylinder on to rollers which carry it to trays, where it is cut into lengths and then taken to the drying-sheds, where it remains about three days. It is then dry enough to be stacked in open racks, where the final drying is completed. The most important feature in this system is the breaking up of the cellular tissues of the peat, and thus getting rid of the fixed moisture; and the remarkable reduction in the size of the blocks of peat during the process of drying shows that this is done in the most complete manner. The condensed peat becomes very firm and solid, and the whole process does not take more than seven or eight days. Messrs. Clayton assert that this fuel can be produced at a cost of from 5s. to 6s. per ton.

Danchelle's peat fuel and peat filters for sewage were exhibited at Manchester in 1874. The samples of manufactured peat fuel made from the light brown moss of Red Moss, Horwich, Lancashire, differed from other specimens of peat fuel in that the humus and ligneous fibre of the peat were macerated and reduced to a state of fine chocolate paste. The machine used to effect this consists of a long cylinder, in which works a shaft armed with proper cutters and discs, by which the crude peat is soon reduced to the consistency of pasty pulp, and issues in a long roll of any shape or diameter. This is cut into briquettes, and the briquettes are dried in the usual way, under a covered shed. In drying they lose in their bulk, but they are in a fortnight converted into a good, hard, fine-grained fuel, and when roasted with charcoal are about one-third their original size. The producers of the Danchelle peat fuel also convert the peat into sewage filters by incorporating the peat with a mixture of clay and charring them. Experiments have been made and are continued with these filters in Bradford, Yorkshire, and in Paris, and the results are stated to be very satisfactory. Peat fuels are prepared in Sutherland by charring the peat, which has been broken up by a machine, so as to leave it in a rough, granular state, and afterwards worked up with crude shale tar, and pressed into bricks by a moulding machine. The quantity of shale tar taken up by the vegetable peat is very considerable, and gives it a thoroughly carbonised appearance.

Mr. Robert Kerretichison breaks up his peat with a machine, by means of which it parts with a great deal of its water. It is then manufactured in a masticator, and finely-broken asphalt is mixed with the mass. It is then shaped into briquettes and dried under sheds. Its specific weight is less than most other peats, and the addition of asphalt adds to its cost, but gives it greater value for furnaces and for raising steam.

In Austria and some parts of Germany a process obtains of grinding the peat, as rags are ground in a paper mill, by the addition of water, to a very fine pulp, which is placed in suitable receptacles, and by filtration and evaporation relieved of most of the water. It is then cut into blocks, and stacked away for use at a later day. The product is said to be excellent, but the process is slow and expensive.

The treatment adopted at Horwich, Lancashire, presents some points of difference from any of the foregoing. The peat is pulped in a mill arranged for the purpose, and conveyed by means of an endless band to a moulding machine, which cuts it into blocks of any required size. The blocks then travel backwards and forwards in a drying chamber on moving bands exposed all the time to a current of heated air. The product is said to be hard, dense, and of excellent quality.

The apparatus invented by Mr. Buckland, of South Wales, consists of a solid obtuse iron cone, having a spiral groove on its exterior, and revolving vertically within a hollow cone of iron plate, perforated everywhere with small round holes like a colander. The peat is put into the space between the solid and hollow cones, and by the revolution of the former is forced in a worm-like form through the holes in the latter. It is then fashioned into bricks by any convenient machine, and artificially dried. This process is said to produce a good quality of fuel, but to be of small capacity and expensive to work.

Other methods of treatment on the Continent of Europe consist in passing the crude peat in its moist state through rollers which reduce it in bulk, and deliver it in soft blocks or sheets, which are afterwards removed to spreading grounds or sheds to be dried; or in pulping the raw peat, with the addition of considerable water, and dividing it in this state into moist blocks, which are dried in kilns or the open air.

The attempts to convert raw peat into a serviceable fuel have been fewer in the United States of America than in Europe, largely, no doubt, because of the comparative cheapness and abundance of wood and coal in the former country. Nevertheless, the problem has been attacked by a number of experimenters, some of whom have been content to follow European processes, while others have invented plans of their own. It was thought by some of them that the peat as it was taken from the bog could be wholly freed from water by compression, and presses of great power were brought to bear upon it with this belief. Experience showed, however, that a considerable percentage of the moisture is retained by the peat with such tenacity as not to be amenable to pressure only.

(To be continued.)

Trade Notes.

Messrs. D. Y. Stewart and Co., Glasgow, have secured the contract for the pipes for the Barry Links water scheme.

The tender of Messrs. Siemens Bros., London, for the mains for the electric lighting of Bristol has been accepted.

Messrs. G. Ansaldo and Co., of Sampierdarena, have secured an order for seven locomotives for the Rete Sicula Railway, Italy.

Messrs. Desouches David, of Pantin, near Paris, have received an order for 300 wagons from the Northern Railway of France.

The Crown Copper Works, near Skewen, South Wales, which have been idle for more than 20 years, are about to be restarted by a new company.

Messrs. R. and J. Dempster, engineers, Manchester, are putting down plant for the recovery of ammonia and tar from the effluent gases of the blast furnaces at Glengarnock.

Messrs. Vickers, Sons and Co. Limited, Sheffield, have been instructed to make a propeller shaft to replace the one recently fractured on the "Umbria." It is to be of mild steel.

Messrs. Macfarlane, Strang and Co., Glasgow, have received an order for the supply of the 36in. cast-iron pipes required for the new gas main connecting Dawsholm with the Temple Gasworks, Glasgow.

The Fairfield Shipbuilding and Engineering Company are constructing engines to develop 3500H.P. under forced draught for the first-class torpedo gunboat "Hazard," now building in the Government dockyard.

The Babcock and Wilcox Company Limited have declared an interim dividend at the rate of 6 per cent. on the preference, and 10 per cent. per annum on the ordinary shares, for the six months ended December 31, 1892.

Messrs. Ganz and Co., Buda-Pesth, have been awarded the contract for the electric lighting of Sophia, Bulgaria. The power is to be obtained from high-pressure waterfalls, the water being conveyed in Mannesmann steel tubes.

Messrs. Fowler, Lancaster and Co., Birmingham, are fitting up electrical installations in each of the two battleships now in course of construction at the shipyard of Messrs. Palmer's Shipbuilding and Engineering Company, Jarrow.

Messrs. Lucas and Aird, London and Glasgow, who are enlarging the locks, etc., at the West India Dock, London, expect to complete their undertaking in about twelve months. The cost of the enlargements contemplated will, it is estimated, exceed £200,000.

Messrs. Brown, Marshalls and Co. Limited, of the Britannia Railway Carriage and Wagon Works, Saltley, Birmingham, have just made a contract for the supply of all the carriages and wagons required for the equipment of the Northern Railway of the Transvaal. The contract amounts to nearly £100,000.

Messrs. Miller and Co., Vulcan Foundry and Engine Works, Coatbridge, are offering their extensive works for sale as a going concern, in consequence of the death of the senior partner. The works, which have been in existence upwards of half-a-century, include the new foundry, which is said to be one of the largest and most complete in Scotland.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 391, Strand, London, or New Bridge-street, Manchester.

Wheel cutter in metal only. Every description of gearing. R. Chidlaw, 43, City-road, Manchester.

Having regard to the enormous circulation of The Mechanical World, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if Mechanical World readers will kindly bear this in mind as occasion arises

Eighty-ton Shears.

THE rapid increase in the size of the ships built on the lakes, and the corresponding increase in the weight of engines and boilers, have made the introduction of improved facilities for handling heavy machinery almost obligatory. To meet the demands upon them in this regard, the Globe Ironworks Company, of Cleveland, Ohio, has built and erected in its shipyard a set of shears, which we illustrate in this issue. These shears are nominally of 80 tons capacity, but are fully able to handle 100 tons if necessary.

The front legs are 100ft. 5in. long from centre to centre of pins, and are 26ft. apart at the feet. The back leg, which is 130ft. 6in. long between centres, is connected to a screw at its lower end, by which the foot can be moved 40ft. and the moving block 49ft., horizontally. The motive power for these shears consists of a vertical compound engine, which has cylinders 8in. and 14in. in diameter by 12in. stroke. The engine is connected by spur gearing, as shown in the illustration, to a main hoisting drum 48in. in diameter and to a smaller drum 30in. in diameter for light work, and also by bevel gearing to the screw, by which horizontal motion is obtained. The large drum is grooved to receive the hoisting rope, which is a 19-strand steel wire cable, 1⅝in. in diameter. There are five sheaves in the upper block, one of them being an extra sheave for light hoist, and four in the lower block, making eight running parts of the cable. There are two changes of speed in the gearing, which give a speed of hoisting in the gearing with the large drum of 1ft. 6in. per minute at the slowest and 3ft. at the fastest speed. With the same changes the speeds of horizontal motion of the back leg by means of the screw are 3ft. and 6ft.

The shear legs are of steel, and have a rectangular section, the two front legs being 36in. × 44in. in the middle and 20in. square at the ends, while the back leg is 45in. × 50in. at the middle, and 20in. square at the ends. These legs are built up of ½in. steel plates and angles, the joints having double butt straps and being triple-riveted. The corners are connected by 4in. × 4in. angles double-riveted. At the ends of the legs the plating is doubled for a length of 12ft., besides being stiffened the entire length with 3½in. × 6in. angles, and tied across with plates 10in. wide at intervals of 10ft. The top and bottom ends of the back leg have wrought-iron straps bolted on the inside, and are bolted 11in. and 7in. respectively to engage the pin at the upper end and the crosshead at the lower end. The front legs are capped at the top and bottom with cast-iron caps, and are bored through at the proper angle to receive the pins, which are 9in. in diameter at the top and 7in. at the bottom.

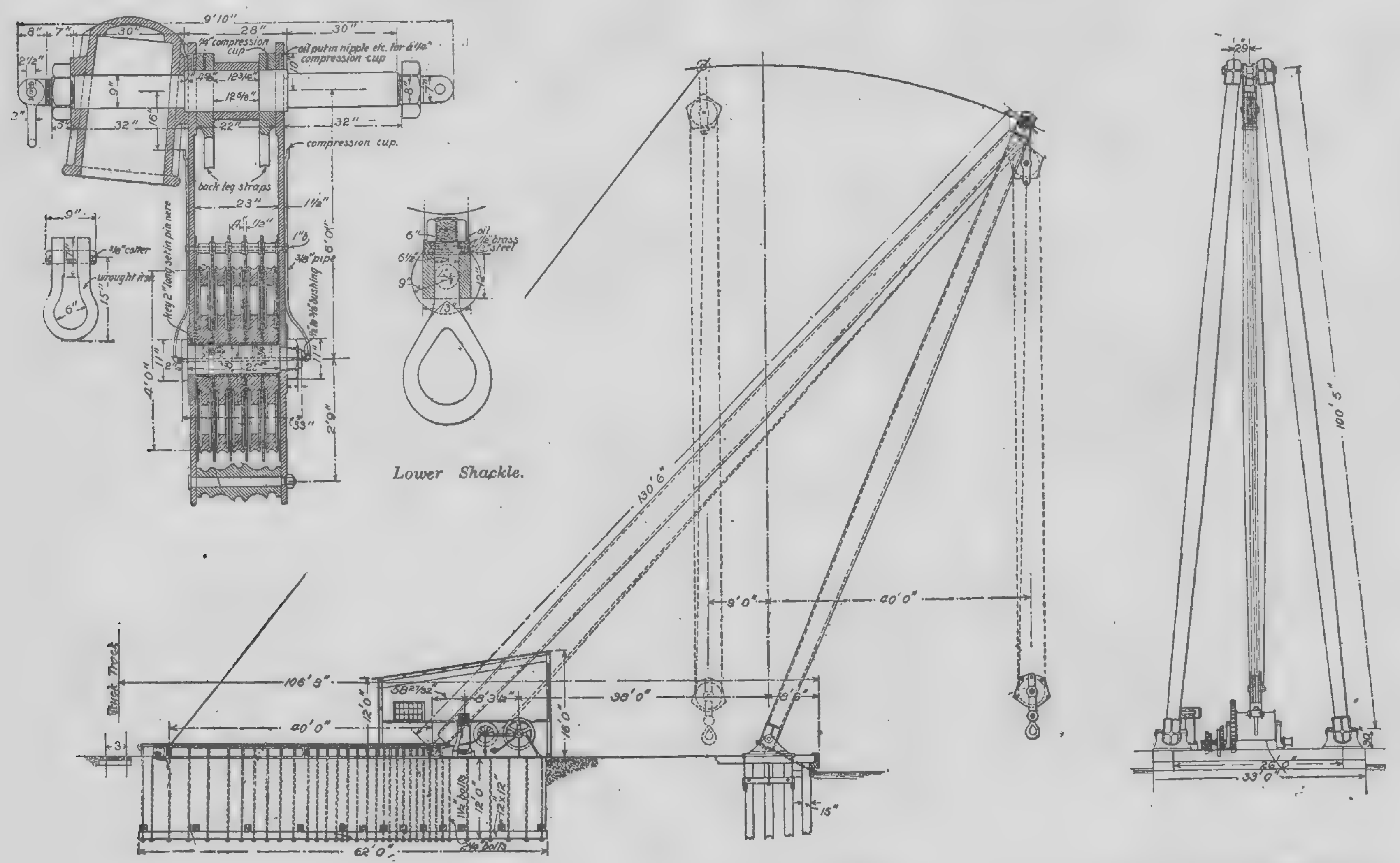
The details of the upper connections are shown in the engravings, with a section of the upper block. The pins at the feet of the front legs rest in pedestals formed in castings 6ft. by 8ft. at the base, which rest on piles at the edge of the dock. This piling is proportioned to give a load of about 10 tons on each pile. Courses of heavy timbering bound in with heavy bolts are built into the piling, forming a table for the pedestal castings, and the piles themselves are joined with cross pieces lower down. The screw by which the horizontal movement is obtained is made of best forged scrap iron, is 7in. in diameter, and is threaded for a length of 43ft., with nine threads to the inch. The thrust is taken by a series of collars at the end of the screw. The foundation at the back of the shears, which, of course, takes a large part of the load, consists of a solid block of concrete 12ft. in cross section and 62ft. long, which is built up on 12in. × 12in. oak stringers and oak cross pieces of the same cross section bolted down to the stringers. The holding-down bolts, as is clearly shown by the drawings, pass through the oak stringers just referred to.

The sheaves in the large blocks are of cast iron 48in. in diameter, turned and grooved, and are bored and bushed with brass to fit the 8in. pins. The details of the upper block and the swivel for the lower block are shown in our illustrations.

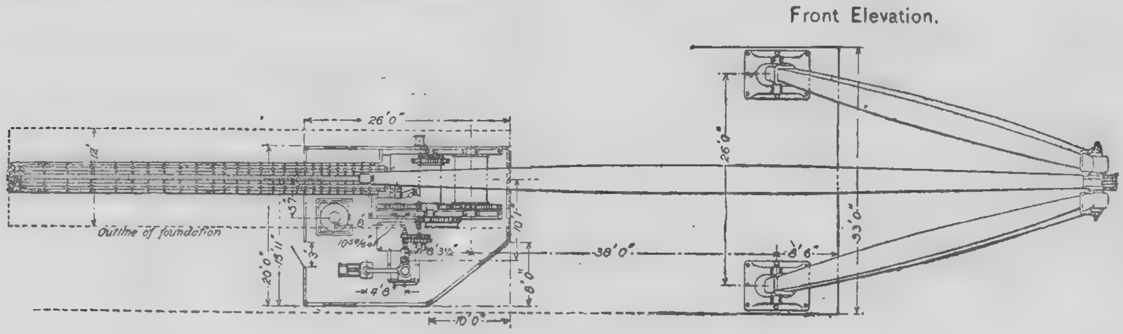
We are indebted for the drawings from which the illustrations are made, and for particulars of these shears, to Mr. Walter Miller, mechanical engineer of the Globe Ironworks Company.—"Railroad Gazette."

Upper Block.

Lower Shackle.



Front Elevation.



Plan.

EIGHTY-TON SHEARS.

Accidents to Hoisting Machinery and their Prevention.*

THE disastrous results of accidents to winding and hoisting machinery in mines, factories, and warehouses, have brought into existence a number of appliances for preventing or lessening the danger resulting from breaking ropes, falling cages, over-winding, and other accidental occurrences peculiar to this class of machinery. The writer proposes to give here the result of his own experience in dealing with hoisting machinery, and a few hints with regard to choosing suitable apparatus, or of judging of the efficiency of machinery already in use.

Most mine managers and owners have adopted steel wire ropes in place of the older hemp rope, but in factories and warehouses manilla ropes and often chains are still used. The working load of a rope is usually fixed at one-seventh of its breaking load, and in most cases this affords an ample margin of safety. The working load of best crucible steel wire rope for various diameters may be taken as follows:—

Diameter.	Maximum Load.
½in.	10cwt.
⅝ ,,	20 ,,
¾ ,,	30 ,,
⅞ ,,	40 ,,
1 ,,	50 ,,

In calculating the load on the rope, not only the combined weight of the cage and its greatest burden, but also the weight of as much of the rope as is unwound when the cage is at the bottom of the shaft, must be taken into account. This being ascertained, the breaking strain of the rope selected should not be less than seven times the aggregate amount, and a further margin may with advantage be allowed for the sudden strain incurred at starting and stopping.

If chains are used, they should be tested at least once in three months, as they are very liable to sudden weakening and subsequent rupture.

Even the best manilla ropes very frequently give way without much warning; and for this reason the wire cable is much to be preferred to either chains or hemp ropes, as the former shows plainly that it is weakening by the breaking or visible wearing of some of its strands.

The shaft-head pulley should bear a certain relation in point of size to the rope running over it. The larger the diameter of the pulley the better, but it ought not to be less than thirty times that of the rope, if wire rope be used.

One of the best makes of wire ropes is that in which the wires are laid into strands, and these into rope in the same direction of spiral, thus exposing a smoother face than usual, and giving greater flexibility.

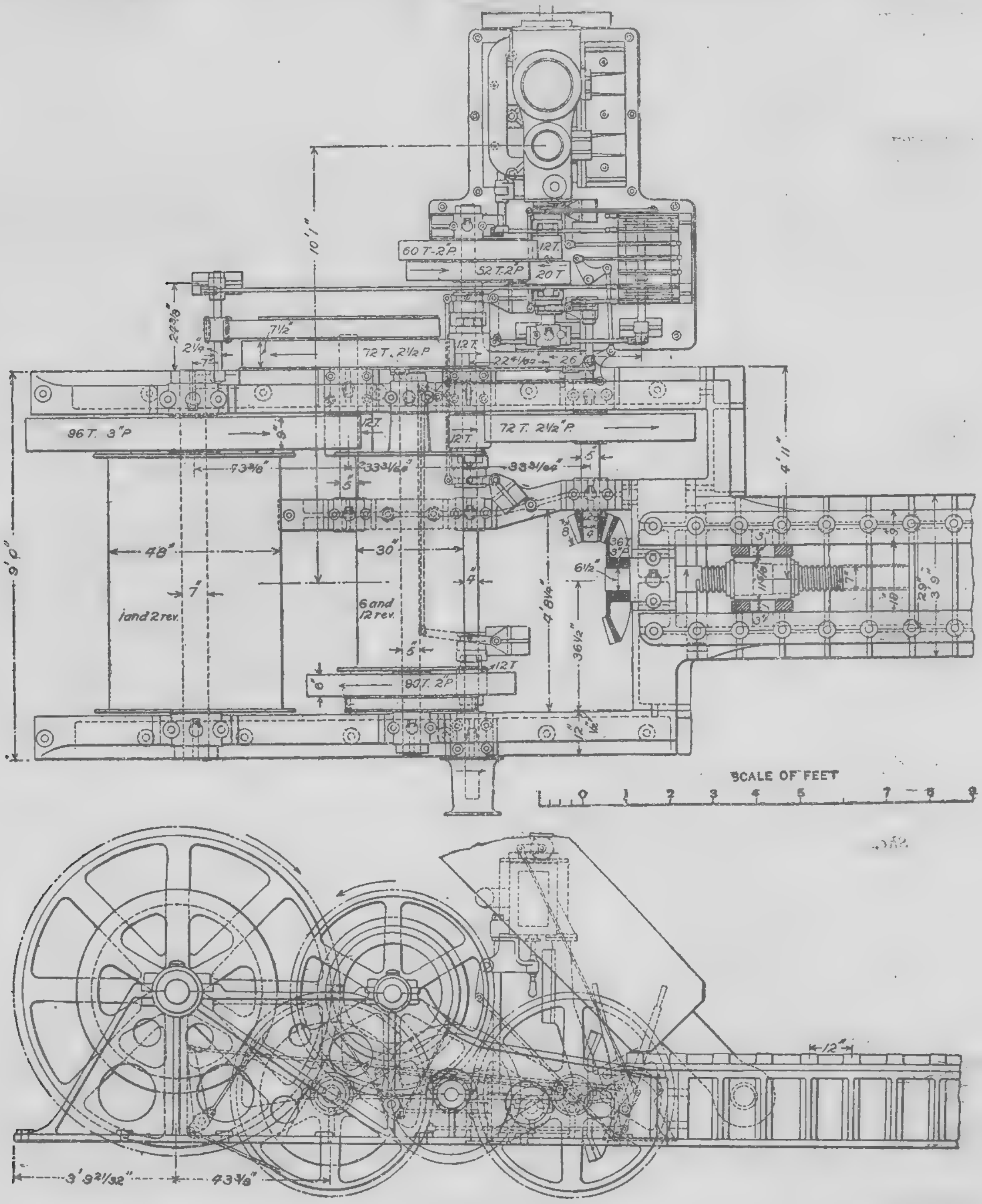
When in use, ropes wear better if some sort of protecting and lubricating coating is used; a mixture of unboiled linseed oil and vegetable tar is one recommended by some.

The diameter and width of the winding drum are matters of some importance. Many practical men recommend that they should be made of such a size that a single lap of rope wound on will be sufficient to raise the cage from its lowest depth to the top of the shaft. As to the minimum diameter permissible, some rope makers claim that their ropes only require a drum of from six to eight times in diameter what the rope measures in circumference; but the usual practice is to make the drum about 40 to 60 times the diameter of the rope.

* This article has been awarded a prize in our Competition.

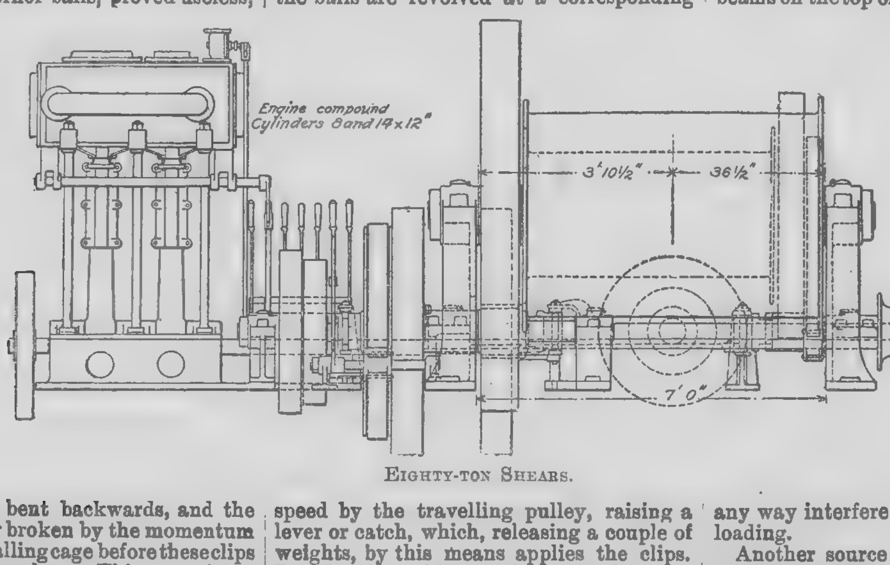
The drum is best made with cast-iron sides, connected by a boss, so that both sides are driven by the shaft, and no strain is put on the lagging on which the rope winds.

Careful and regular inspection of all parts of the winding gear is essential, and any signs of weakening should be taken note of at once and seen to.



Eighty-ton Shears.

On one occasion within the writer's knowledge, a manilla hemp hoist rope was noticed by the hoistman to have worn somewhat near the cage hook. A new rope was ordered and arrived within two days, but on the morning before it was intended to replace the old rope, it gave way without further warning, and the cage, with its load, was precipitated nearly 30ft. down the shaft. A safety catch, actuated by governor balls, proved useless,



Eighty-ton Shears.

as the clips were bent backwards, and the whole of the gear broken by the momentum acquired by the falling cage before these clips were brought into play. This case shows the urgent necessity of immediate attention to first signs of wear, especially in hemp ropes Even with the greatest care, however, hauling and winding ropes frequently give way, causing serious loss of life and damage to property. To prevent the falling of the cage, a safety catch is sometimes fitted to it. The construction of these catches varies in different patterns, but nearly all aim at stopping the downward course of the cage by forcing spikes or clips, suitably attached thereon, into the wooden guide rails between which the cage slides, and which are fixed to the sides of the shaft at the four corners.

One make of safety catch which was formerly much used, and which is still frequently seen, is made to work by means of a pair of governor balls revolved by a short strap working on a pulley which slides on one of the guide rails. When the downward speed of the cage exceeds a certain point, the balls are revolved at a corresponding speed by the travelling pulley, raising a lever or catch, which, releasing a couple of weights, by this means applies the clips. By the time this speed is reached the falling mass has of course acquired a certain momentum, and in many cases this is sufficient either to break or bend the clips, and so render the gear useless. An easy solution seems to be to make these parts strong enough to stand the shock; but even then it is very probable that they would simply be torn out of their hold, and the cage would go on falling, always gaining speed during the intervals between the checks received as the clips caught the guide rails.

Perhaps one of the best safety catches in the market is that in which the actual parting of the rope releases a number of springs—usually one at each corner of the cage top—which force the clips, held horizontally in guides, outwards into the rails. The catch is thus applied before the cage has acquired any appreciable downward motion. The whole of this mechanism is attached to the cross beams on the top of the cage, and does not in any way interfere with the loading or unloading.

Another source of danger lies in overwinding—that is to say, hauling the cage upwards until it comes in contact with the framework supporting the pulley, and thus breaking the rope. Care on the part of the engineman or hoistman greatly reduces the likelihood of this occurring; but should it happen through carelessness or by loss of control over the machinery, a smash is sure to result. A patent safety hoisting hook is made by a well-known London firm of engineers, which, if attached to the cage, and overwinding takes place, passes a fixed supporting plate, and the rope and part of the hook become detached by means of a crossed lever arrangement within the hook, and the cage remains suspended from the plate. The opening of the crossed levers which released the shackle also serves to throw out two lugs from that part of the hook which has passed through the slot in the supporting plate, thus preventing the cage from falling. The shackle can be reattached in a short time and the cage lowered.

Regular testing of ropes and chains, and inspection of all parts of the hoisting gear, serve to prevent a great number of mishaps; and if a reliable safety catch be fitted to the cage and kept in proper working order, very few indeed of the accidents to hoisting gear will be of a serious nature.

F. W. H.

Mechanical and Engineering Drawing.—III.

By a Practical Draughtsman.

In cases where many parallel lines have to be drawn, of lengths beyond the capabilities of ordinary set squares, and in directions other than square with, or parallel to, the working edge of the drawing-board, it is convenient to have for use an *adjustable*-bladed tee-square, or one whose blade can be set at any desired angle. The blade of such a square should be tapered as in Fig. 4, but shaped at its wide end as in Fig. 5, and have a stock wide enough to allow for the surface required in

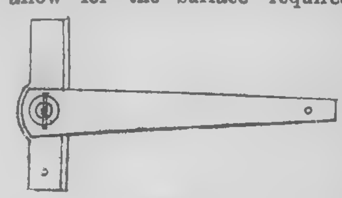


Fig. 5.

the washers of the fittings necessary to make the blade adjustable. These fittings, though requiring to be well made and neatly finished, are not expensive or difficult to make, as they consist merely of two washers, a square-necked bolt, and a fly-nut, articles that anyone capable of making a pair of calipers could supply himself with. Fig. 6 shows a section of these fittings, which are generally made in brass. The top and bottom washers A, B, are slightly dished on their faces to ensure contact with blade and stock, and the spread of the wings of the fly-nut is such as to give sufficient leverage for a good grip.

Reference is here made to an adjustable-bladed square, as one may possibly be required later on by the student; but there is no present necessity for the provision of such a tool, as all lines that may be required other than those drawn with the tee and set squares in conjunction, are easily put in by a proper manipulation of the set squares, which will be explained in due course.

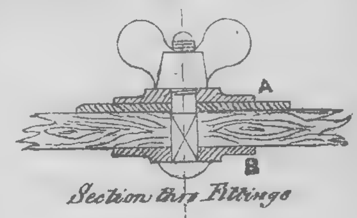


Fig. 6.

Of the *set squares* used conjointly with the tee-square, those of 45° and 60° are all that are required by the student in the earlier stages of study. A 6in. 45° and an 8in. 60° set squares are the most useful sizes. Framed ones, well made, of foreign manufacture, may now be obtained at a reasonable price, but the kind most generally in use are made of vulcanite. Those, however, of this material made with the middle part cut out to imitate framed wooden ones should be avoided, as they are very liable to fracture at the angles, and it is impossible to repair them.

The other requirements of the student of mechanical graphics, apart from what are known as *instruments*, are some pencils, drawing pins, rubber, paper, and ink. A few words descriptive of the

qualities that should obtain in each of these articles, that satisfactory work may be done, will be of advantage to him.

The present great demand for *pencils* has, notwithstanding the millions that are annually made and sold, added few to the number that are specially suited to the wants of the mechanical draughtsman. Many erroneously assume that any sort of pencil will suit a learner. No greater mistake can be made. If he is to acquire a draughtsman's habit of work, his first necessity will be a good, serviceable, reliable pencil—one that is neither too hard nor too soft, and that will retain a good point for a considerable time. The pencils now generally used in drawing offices are of Faber's make, which can be had of different degrees of hardness from H to six H's, the cedar covering of the lead being hexagonal in form, instead of round. But such pencils are too expensive for students' use. A good, serviceable pencil, made by Cohen, and known as the "Alexandra H pencil," has been in use by the writer for some years, and costs about half the price of Faber's. They are, however, of the ordinary round form, which is inimical to the draughtsman, tending to cause them to be constantly rolling off his board and damaging their points. To obviate this the writer's practice is to cut a flat side on the pencil throughout its whole length, taking care not to bend the pencil in doing this for fear of breaking the lead. If neatly done a perfectly flat side is produced, which serves as a guide to the way in which the pencil should be pointed and held, and will prevent any tendency to rolling, even if the drawing-board is much inclined. To do away, however, with the necessity for constantly sharpening the pencil, and thereby reducing its length at every such operation, pencils with movable leads have been in use in drawing offices for some years. They are much to be preferred, as the part of the pencil which is held by the fingers never alters in length, and the lead can be used to the last quarter of an inch. This kind of pencil is known as "Faber's artist's pencil," is hexagonal in outside form, and thus partly prevented from rolling. The acme of perfection in this class of pencil has, however, only lately been introduced, the part for holding the lead being triangular in section, which renders it easy to hold without turning in the fingers, and rolling off the drawing-board is impossible. It is made by Hardtmuth, of Vienna, but can be purchased of any photographic chemist or artists' colourman.

(*To be continued.*)

Gas-power for Electric Lighting.

At the ordinary meeting of the Institution of Civil Engineers held on Tuesday, the 10th inst., Mr. Harrison Hayter, president, in the chair, the paper read was on "Gas-power for Electric Lighting," by Mr. J. Emerson Dowson, M.Inst.C.E.

The author stated that in Great Britain alone gas engines had been sold for electric lighting exceeding in the aggregate 7000H.P., and that in Germany engines were used for about 1100 arc and 90,000 glow lamps. It was, however, only within the last few years that gas engines of large size had been before the world in a practical form. The varying load-factor in central stations was a serious trouble, and the author hoped to show that much of the present loss, due to fuel, water, and wages, would be avoided if gas-power were used instead of steam-power.

Special reference was made to the central station at Dessau, belonging to the German Continental Gas Company. That station was opened in 1886 with two 60H.P., one 30H.P., and one 8H.P. (effective) engines, worked with town gas, and all the dynamos were driven by belting and counter shafts. In 1891 considerable alterations were made. One 60H.P. engine, with its belting and counter shaft, was retained, and one of 120H.P. introduced, coupled direct to its dynamo. The speed of the engine and coupled dynamo was 145 revolutions per minute, and the consumption of town gas was equal to 39cub. ft. per kilowatt. Formerly, without accumulators, it was thought necessary to adjust the size of the engines to the supply, so that they should always be worked to their full extent. It had, however, been found that a limited supply could more advantageously be furnished entirely from accumulators. In spite of the loss of about 21 per cent. in the accumulators, large engines worked more profitably in parallel than smaller ones supplying direct without accumulators. Since February, 1889, the municipality of Schwabing, a suburb of Munich, had used an Otto engine worked with Dowson gas for 10 arc and 300 glow lamps. The load was variable, but with an average output of 22·5 kilowatts per hour the fuel consumption was 3·3lb. per kilowatt. The town of Morecambe was lighted by 9 arc lamps and glow lamps, equal to 1600 of 8C.P. each, the dynamos being driven by Stockport gas engines worked with Dowson gas. With an output of only 1155 kilowatts per week the consumption of fuel was 2·58lb., and the cost of the gas, including wages and fuel, was ½d. per kilowatt delivered. At the chateau of Mr. Say, at Longpont, in the South of France, there were 650 glow lamps and 1 arc lamp, supplied by a dynamo driven by a Crossley engine worked with Dowson gas. The consumption of fuel was 1·2lb. per I.H.P. and 2·71b. per kilowatt per hour.

It was believed that the late Sir William Siemens first drew attention to the fact that when illuminating gas was burnt in a gas engine to drive a dynamo much more light was produced electrically than could be produced by burning the same quantity of gas in burners in the usual way. Latterly, the consumption of gas per horse-power in gas engines had been reduced, and the ratio was at the present time about 20 to 1 in favour of converting the gas into an arc light by means of a gas engine. The author had collected data from various sources as to the consumption of ordinary town gas by engines supplying electric light, with and without accumulators. The average of all the returns, with engines under varying loads and without accumulators, was about 47cub. ft. per kilowatt-hour; when accumulators were used, the consumption of gas was less, because the engines then worked under a full load. With 47cub. ft. per kilowatt, and 55 watts per 16C.P., one light of that power required only 2·6cub. ft. per hour; whereas a standard Argand burner required 5cub. ft. per hour. In this comparison it was assumed that the glow lamps and gas burners were in good order; but under ordinary working conditions they did not maintain so high a duty.

The question of load factor was a serious one with any type of engine, but with gas engines the loss was much less than with steam engines. When a gas engine was stopped, its consumption of fuel stopped also, and there was no furnace to maintain; nor was there any water to boil at starting. At the same time, it was desirable that the gas engine should be worked as much as possible under a full load, and in this respect the experience at Dessau was generally confirmed. A central station was worked under trying conditions, and in the London district there was only a full output of current during from 3 to 5 hours in every 24; moreover, about 60 per cent. of the total output was required during that short period. In practice, this meant that in a station where the current was supplied without accumulators, the engines were run at a reduced speed during a portion of the time, and at other times some of them were stopped altogether; but all had to be ready to work in the evening, and occasionally in the day time, when there was fog. Generally, it might be assumed that the average consumption was more than 6lb. per kilowatt where accumulators were used, and about 9 to 12lb. where they were not used. In any case, with the best possible arrangement of steam-power there must be a large amount of fuel consumed which did no useful work; for even if some of the fires were drawn they had to be relighted, and the large quantity of water which had cooled during the time of standing must be reheated.

The author believed that the solution of the difficulty was to be found in the use of gas plant instead of steam plant. With a large gas engine, one brake horse-power per hour could be obtained with the consumption of about 1lb. of anthracite or 1¾lb. of coke; whereas the consumption of coal with the steam engines used for central stations must be taken at about 2½lb. per brake horse-power when working under a full load. A saving of not less than 50 per cent. could therefore be effected in stations where the engines were fully loaded; and where there were great fluctuations in the output, the loss of fuel with boilers not used, or only partly used, could be almost entirely avoided. For a maximum of 400 kilowatts there would be three gas generators, each capable of supplying one third of the maximum required. The production of gas could be raised or lowered in several ways, and the working of each generator could be stopped immediately by shutting off its steam supply. Supposing, therefore, that all three generators were working at their maximum rate, and a gradual reduction was required, this could easily be effected; and when the production of one or two generators could be dispensed with, their operation was at once stopped. The third generator could then be kept at work, and its production adjusted to suit the minimum consumption required. A gas generator had a small grate area compared with that of a boiler, and much less cooling surface; it contained no water, and required no chimney draught. A generator of the size referred to lost only 6 to 8lb. per hour whilst standing. If an average of only 40 per cent. of the maximum power were required for 21 hours, it was equivalent to letting two of the generators stand for that period; and at 8lb. each per hour, that meant a total loss of only 3cwt, compared with the much greater waste when steam-power was used. As the use of large engines, driven with generator gas, was of recent date, the author proceeded to describe the gas plant used, and gave the results of engines working regularly with Dowson gas under the usual conditions obtaining in factories. He also gave the results of brake tests made with several engines of large size, and reproduced indicator diagrams taken from engines of different makers. Although admirable results had undoubtedly been obtained from engines working with the Otto cycle, he was of opinion that, with engines of large size, the results would be still better if the cycle were altered, especially when generator-gas was used. His reasons for this were fully stated in the paper.

The following was a summary of the points urged by the author :—

(1.) When town gas was used for driving the engines of an electrical station, the consumption was about 50 per cent. less than the volume of gas required to give the same amount of light by ordinary burners.

(2.) When town gas was used, neither boilers nor firemen were required, and there were no ashes to remove; less space was needed; no accumulators were required, except such as might be necessary to equalise the load of the engines and to provide for a small amount of storage. The engines could be worked in the most crowded districts, close to where the lights were required, and where boilers were not allowed.

(3.) When generator-gas was used, the consumption of fuel under a full load would be at least 50 per cent. less than with steam power, and the loss due to steam boilers not being fully worked could be almost entirely avoided.

Methods of Riveting Steel Plates.*

As riveted joints are often the cause of deformed or ruptured sections, their study is of great importance from the point of view of stability. Let us first examine the preparation of the plate and the piercing of the rivet hole. This piercing is performed either by means of the riveting punch or the drill. Speaking generally, this latter mode of working with the drill is more expensive, but causes less deterioration in the quality of the metal. Punching injures the metal round about the opening. It has also the disadvantage of deviating more or less, which necessitates drilling to secure the meeting of the rivet holes. Punching is especially bad for cast steel, in proportion to the degree of hardness possessed by the metal.

In several constructions, notably in France, holes have been punched with a diameter from 2mm. to 3mm. less than the required diameter, and finished by drilling. It is maintained that the deterioration produced by punching diminishes from 20 to 23 per cent. the resistance of the steel in symmetrical unions, and from 32 to 37 per cent. in joints with a simple union. Thus, if the punching of a plate diminishes its section by 20 per cent., the resistance of the dangerous section will be 0·54 of the resistance of the plate in other parts. The limit of elasticity of iron and steel being about 0·54 of the resistance to fracture, it will be seen that simple cover joints must break in the dangerous sections before taking an appreciable elongation.

Experiments made for the Paris-Lyon-Méditerranée Railway Company show that the drilling of the holes punched increases from 200 to 1000 per cent. the force necessary for the fracture of bars tested by blows. Punching, which is not done without injury to iron also, though somewhat less than is the case with cast steel, gives more exact results than boring. Moreover, it is in hard metal especially, which is but little employed, that punching is particularly injurious. It would appear an exaggeration, according to the average of experiments made, to attribute to the punching of steel plates a diminution of resistance amounting to as much as 25 per cent. It is, nevertheless, known that fractures of steel bars with 55kilos. of resistance, bored or drilled and not forged, are much rarer than of the punched iron usually employed.

In our metallic constructions the rivet constitutes the principal, if not the only mode of union. A joint, in order to be solid, should alter the shape of the metal as little as possible, and transmit the force along the axes of the bars converging to the centre. Theoretically the joint, without being rigid, must constitute a true articulation permitting of the elasticity of the whole metallic system. But the results of practice have already deprived this last condition of all its importance. It is true that the rivet widely used in Europe constitutes a rigid joint. The American engineers have much praised and applied, instead of riveting, the pivot joint, a lighter joint, and one more rapidly executed. Theoretically it was believed that a pivot joint, leaving a certain degree of liberty to the pieces, best realised the fundamental conditions of the articulated system, and ought consequently to give more solidity to the construction, by approaching nearer to the hypotheses of calculation. In a lattice girder the union by pivot of the parts of the lattice work and the pieces of the lower rib constitutes a kind of chain. In American girders each knot of the lower rib is a pivot uniting at least four bars. In this sytem great efforts are produced in the articulation, which from the absence of the joint are distributed unequally over the surface in contact.

A European system may now be mentioned which constitutes a rigid whole, but one that is practically an improvement as regards stability. The stem of the rivet must not be of too large size—10cm. appears to be the practical limit,—because the contraction on cooling would exercise too violent an action. The spherical cap forming the head of the rivet is proportioned in its dimensions to the size of the stem. This head has an average diameter at the base of 1·8 time the diameter of the stem, and its height is 0·6 of the same diameter.

Rivets have been employed very advantageously with flat heads and sides which fit well in the countersinking of the plate. This rivet renders the angles less acute, both on the head of the rivet and at the opening of the plate. Experience has proved that the thickness of the superimposed plates ought not to exceed five times the diameter of the rivets, and that the holes for rivets which are fastened by hand should be slightly larger when there are more than two plates.

The union of steel framing has given rise to considerable discussion, bearing especially on the choice of iron or cast-steel rivets. The steel rivet was questioned on account of its being less weldable, and because it did not work so well hot. But rivet stems are now made of extra soft steel, which is specially suitable for this class of work. The extra soft metal employed has a breaking strain of 38kilos., with an elongation of 28 to 32 per cent. The rivet metal is weldable cast steel—that is to say, an extra soft steel containing 0·08 of carbon, with an average of 0·30 of manganese. Many constructors do not approve of this method, and only allow the iron rivet. It may be remarked that riveting by machinery, which is more powerful and much more rapid than by hand, is especially suitable for steel riveting, which is more promptly achieved at a constant temperature. Extra soft steel rivets stand heating without difficulty, which ought not, however, to exceed bright red.

The head naval constructors of the English Admiralty have carried out a series of important experiments by submitting two plates superimposed and united by a rivet 19mm. in diameter to a breaking strain, and it was ascertained that :—(1.) With two plates of iron, and the rivet also of iron, the breaking strain was 10 tons, or 36kilos. per square millimetre of broken section. (2.) With two plates of steel and the rivet of iron, identical with the preceding, the rupture was produced with 8¼ tons, or 29·6kilos. per square millimetre. (3.) With two steel plates united by a steel rivet, the breaking strain was 11⅓ tons, or 41kilos. per square millimetre. The riveting in these cases was done by machinery.

The question has also been discussed whether the heat possessed by the rivet would not be sufficient to produce a certain measure of annealing. This would, however, only be in particular cases, which can be avoided by good working. Riveting when hot closes the plate up in a better manner, except that by cooling the stem diminishes in diameter, and thus cannot fill the whole space of the rivet hole. In this respect, mechanical work, on account

* "Colliery Guardian."

of its closing the plates together, is obviously superior. Riveting by hydraulic pressure, which is now much employed, avoids the disadvantages produced by blows in the working of the steel, especially during the formation of the rivet exposed to cooling. It has also been ascertained that the contact of the punch may deteriorate the metal.

Experimentally, it is proved that for hand-placed rivets the resistance to cutting is only 80 to 85 per cent. of the resistance to breaking by traction. Machine riveting gives greater resistance to cutting, because the rivet well heated in every part sustains a more powerful compression. This advantage of the compression of the stem of the rivet into all the irregularities of the hole formed by the non-agreement of the plates in their superposition is often found when the joint is being separated. After having taken off the head, it is very difficult to remove a rivet which has been placed by machine, just because the metal fills up all the irregularities of the hole.

Large riveting machines are only suitable for the workshop, where, no doubt, the work can be more carefully done than it can be on the spot; but it has also disadvantages, one of which is the increased cost. The ordinary type of riveting machine for which unquestionably hydraulic power is preferred, on account of its slow and regular action, is the Delaloe and Piat machine. A frame in the form of a C bears the cylinder in which the punching piston works. This frame also supports the fly-wheel, the steam gauge, and the compressor. This apparatus, employed in 1888 for the construction of the Borne Bridge, was not able to place more than 23 per cent. of the rivets. The improvements which have been made refer mainly to the isolation of the riveter from the compressing apparatus. A movable transverse bridge is placed over the principal girders; on this bridge a small apparatus on wheels supports the compressor and its accessories. The riveter itself on the C-shaped frame with the cylinder is united to the compressor by a metal tube. A special arrangement enables the punches to be placed jutting out from the frame, so as to reach the angles.

The advantage of being able to perform good riveting on the spot must not be lost sight of. Not only is this in certain cases indispensable, but the cost of transport is also diminished. Great improvements have been made in the very light portable machines which are capable of being employed for this work where needed. For heating the rivets there are small blast forges, petroleum furnaces, or movable furnaces with ventilator, completely heating the rivet. The riveting itself is performed by means of small hydraulic presses. Light and very portable hydraulic machines are notably employed at the Toulon Arsenal for piercing plates on the spot. With accumulators and a supply of water under pressure, the workshops are provided at various points and in a convenient way with motive power for manipulating the material and working a series of machines. In a workshop of this kind the plates can be pierced on the spot, and after the plates are fixed in position, even the two holes can be made at the same time. These machines are light, and make 150 revolutions per minute. They work in very confined spaces, and can be carried by one man. These improvements, with careful supervision, are capable of giving excellent results in large undertakings.

Metal Trade Memoranda.

In the month of December there were only 23 furnaces in blast in South Wales, out of a total of 95.

The Arizona Copper Company's mines, during the month of December, produced 341 tons of black copper and 26 tons of matte. This is equivalent to about 359 tons of black copper.

It is stated that the Anaconda Copper Mining Company, Montana, have paid off 600 men at the Anaconda and St. Lawrence Mines, and that no ore will be shipped to the smelter for about 60 days.

The total output of gold in the Witwatersrand district, South Africa, during December, amounted to 117,748oz., against 106,784oz. in November last, and 80,312oz. in December, 1891.

The total yield of gold in the colony of Victoria during the year 1892 amounted to 663,000oz., showing an increase of 41,000oz. as compared with 1891. The output is the largest since 1886, when the yield was 665,196oz.

There are about 770 blast furnaces erected in the United Kingdom, and not one-half of these are now in operation. The idleness is the largest in proportion in the older districts, such as Staffordshire, but in Cumberland the proportion is also large.

The dispute between Messrs. Charles Cammell and Co. and their Workington hands has been arranged by the men accepting a reduction of $2\frac{1}{2}$ per cent. in cases where the wages are under 25s., and 5 per cent. where the earnings exceed that sum.

The Scottish Ironmasters' Association have issued a return showing the figures of production, consumption, export, and stocks of Scotch pig iron (including hematite and basic) for the year 1892. The production for the year amounted to 977,213 tons, an increase on 1891 of 302,788 tons. The consumption in foundries was 146,123 tons, a decrease of 13,305 tons; in malleable iron and steel work, 521,125 tons, an increase of 285,973 tons, making a total of 667,248 tons, and an increase of 272,668 tons.

It is stated that the Germans are sending steel into the centre of England at prices against which native makers cannot compete. Steel plates for gasometer, mining, and engineering purposes, and steel rods for rivet, screw, and wire making, are coming over at prices which Staffordshire and Mid-England steel makers cannot accept, unless at considerable loss. German steel rods are £6 delivered, and plates in proportion. The exceedingly low through Continental rates allowed by the railway companies make this remarkable competition possible.

Official Gazette.

Partnerships Dissolved.

A. L. Adams and H. Hill, under the style of Hill and Co., Aldersgate-buildings, E.C., manufacturers of electrical, optical, and mechanical apparatus.

J. C. Taite and T. W. Carlton, under the style of Taite and Carlton, Queen Victoria-street, E.C., engineers and commission agents.

THE BANKRUPTCY ACTS, 1883 and 1890.

Orders Made on Application for Discharge.

John Corrigan, late Manchester, machinist; unconditional discharge granted.

Charles Edward Masterman, Alsager, Cheshire, late Kidsgrove, as a member of the successive firms there of Renshaw, King and Co., and King, Masterman and Terry, engineers and ironfounders, engineer's outside manager; discharge granted subject to certain conditions.

Adjudication.

Robert Best Mills, Kettering, machinist.

New Companies.

Waterhouse Electrical Manufacturers Company Limited. — This company was registered on the 9th inst., with a capital of £20,000, in £1 shares, to adopt and carry a certain agreement into effect; to apply for purchase or otherwise acquire any patents or brevets d'invention for any invention, and to carry on or engage in any business that may be calculated to become profitable to the company. The number of directors is not to be less than 3, nor more than 5; qualification, £100. Registered by Russell and Arnhole, 17, Great Winchester-street, E.C.

Herculite and Electrical Manufacturing Company Limited.—This company was registered on the 11th inst., with a capital of £12,000 in £1 shares, to enter into a specified contract, and to carry on in the United Kingdom and elsewhere the trade or business of manufacturers of and dealers in the moulded article for the compound of which Mr. Joseph Lang has taken out a provisional specification for Patent 3240, and to manufacture or otherwise deal in any materials, machinery, apparatus, appliances, articles, or things required for the above object. The number of directors is not to be less than 3, nor more than 5; qualification, £250; remuneration, £300 per annum and percentage. Registered by Saunder, Bennett and Co., 68, Coleman-street, E.C.

Stephens and Co. Limited.—This company was registered on the 7th inst., with a capital of £20,000, in £1 shares, to acquire by purchase from John Stephens, of Cuba-street, Millwall, E., electrical engineer, etc., the freehold and leasehold land and buildings situate in Cuba-street, E., where he now carries on the business of electrical and general engineer, and among other things to prosecute the businesses of electricians, mechanical engineers, manufacturers, and workers and dealers in electric motive power and light, and any business on which the application of electricity or any like power is or may be useful, convenient, or ornamental; and to manufacture and produce and, either as principal or agent, trade and deal in any articles belonging to such trades as are mentioned above. Mr. John Stephens is to be the managing director, and the board, irrespective of him, is not to consist of more than 3; qualification, £100; remuneration to be determined by the company in general meeting. Registered by Close and Co., 23, Great Marlborough-street, W.

The Metal Market.

PRICES CURRENT.

LONDON, Jan. 16.

Copper opened a shade easier at £45 18s. 9d. cash, and then went to £45 17s. 6d., after which early February dates passed off at £46. Values varied little for some time, owing to the lack of feature, but afterwards cash rallied to £45 18s. 9d. on less disposition to sell, and £46 7s. 6d. was paid for three months. On the kerb £45 8s. 9d. was made for the latter position, and the final tone was steady without change from Friday's values. Sales, 500 to 630 tons. Settlement price, £45 17s. 6d.; English tough, £49 10s.; best selected, £51; strong sheets, £59.

Tin began with a cash buyer at £91 7s. 6d., but holders were reserved. Subsequently three months was offered at £92, and quickly taken, after which a strong speculative inquiry developed, and three months advanced to £92 5s., which was also paid for early February and middle March. Cash was done early at £92 2s. 6d., and then at £92 7s. 6d., ruling firm at the latter price. Australian (Mount Bischoff) made £93 to £92 7s. 6d., and final rates were 17s. 6d. to 20s. above Friday's rates. Sales, 60 to 70 tons. Settlement price, £92 7s. 6d. English ingots, £95 to £95 10s. The official return of Straits shipments during the past 14 days gives a total of 1820 tons, London taking 1300, America 200, and the Continent 320. The deliveries ex warehouse over the same period have been 491 tons, while 1102 tons have been landed, and warehouse stocks here are now 3793 tons, against 2776 tons at the end of December.

Pig iron again opened strong on continued good buying, Scotch cash rising $4\frac{1}{2}$d. to 43s. $4\frac{1}{2}$d., and one month made 43s. 4d. to 43s. $4\frac{1}{2}$d. For six weeks 42s. was the ruling price. There was little doing towards the close, and final rates were $\frac{1}{2}$d. to $1\frac{1}{2}$d. below the best. Middlesbrough made 35s. 11d. for cash, a loss of 1d., but hematite finished with a gain of 3d. Settlement prices: Scotch, 43s. 3d.; Middlesbrough, 35s. 11d.; hematite, 46s. 3d.

Tinplates remain dull. I.C. cokes, f.o.b. London, 12s. $7\frac{1}{2}$d.; Liverpool, 1 s. $1\frac{1}{2}$d.; Swansea, 11s. $7\frac{1}{2}$d.

Lead is steadier on limited offerings and a better demand, closing sellers Spanish at £9 13s. 9d. English, £9 17s. 6d.

Spelter is in request at £17 17s. 6d., and while there are sellers at £18, business in one quarter has been done at £17 18s. 9d. Silesian specials nominal.

Zinc Sheets. — Silesian remain quiet at £21 5s. ex ship, sellers. Belgian unchanged; V.M. brands, £21 15, ex ship London and £21 10s. to £21 12s. 6d. f.o.b. Antwerp.

Official Closing Quotations.

	To-day. £ s. d.	£ s. d.
Copper—		
G. M. B.—Cash	45 18 9—	46 6 3
" Three months	46 7 6—	46 15 0
English tough	—	—
Best selected	—	—
Strong sheets	—	—
Tin—		
Fine foreign—Cash	92 7 6—	92 17 6
" " Three months	92 5 0—	92 15 0
Australian—Cash	92 17 6—	93 7 6
Pig Iron—		s. d.
Scotch warrants—Cash		43 3
" One month		43 4
Middlesbrough—Cash		35 11
" One month		—
Hematite—Cash		46 3
" One month		—

GLASGOW, Jan. 16.—Business was moderately active on the pig-iron market, which continues disturbed by the stiffness which rules the price of cast iron. Warrants were very scarce, and those credited with the squeeze were lenders, which seems to forecast an end to the operation. While the cash price stood at 43s. 6d., three months' fixed was still freely offered at 42s., but few buyers were about. 15,000 tons sold, and the close was steady at a slight reaction from the best. The shipments of Scotch last week were 7892 tons, an increase on the previous week of 2408, but a decrease for the year is shown of 1053 tons.

Quotations.

	Highest. s. d.	Lowest. s. d.
Scotch warrants—Cash	43 6	43 1
" One month	43 4	43 4
Middlesbrough—Cash	35 10	35 9
" One month	—	
Hematite—Cash	46 6	46 3
" One month	—	—

Letters to the Editor.

We do not hold ourselves responsible for opinions expressed by correspondents.

The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.

Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

AMERICAN AND BRITISH WORKMEN AND MACHINERY.

To the Editor of The Mechanical World.

Sir,—The able letter appearing in your issue for the 6th inst., under the above heading, shows that your correspondent who signs himself "An Englishman" is master of the subject upon which he treats, and I, along with many others of your readers, would like to read more of his experiences and comparisons. It is not everyone who has the time or inclination to expose in the trade papers the fallacies and swagger of the Yankee.

The conditions of life and of trade in America are different to those experienced here by the Anglo-Saxon. The possibilities of the country are greater. Nature's works and requirements are more gigantic in the United States than in our own small and over-populated country. But I wonder what country has furnished the Yankee with the capital and trade to overcome the enormous debt which the American Civil War incurred. Who has opened her markets free to be flooded by American produce, whilst her own agricultural interests have been cruelly starved to death? Why, England, the much-abused mother country, who has defrauded herself and her colonies that an ungrateful and boastful nation (her offspring) might build a wall of tariffs to cripple, and, if possible, ultimately destroy her. C. E. Hall.

Sheffield, Jan. 9.

Miscellaneous Items.

The Northern Railway Company of France, after satisfactory experiments, have decided to light all their trains by electricity.

Electric light in railway carriages will soon be in use in two of the trains on the line from Turin to Rome, and in two on the line from Milan to Rome.

Small electric lamps, such as are used by the ticket inspectors on the London omnibuses, are about to be introduced in the Liverpool omnibuses.

To make glue waterproof, soak it in water until soft, then melt it in linseed oil assisted by a gentle heat. This glue is not acted upon by water or dampness.

A steamer has arrived in New York from Brazil with 658 tons of indiarubber, which is said to be the largest cargo of rubber which has ever left the Amazon for the United States.

The Royal Commission on coast communication, in the interim report recently issued, recommend that five lightships and a number of rock lighthouses shall be connected with the coast by submarine cable, so as to test the advantages of such communication.

A series of lectures on the various "Photo-mechanical Processes of Photography" will be commenced at the Whitworth-street branch of the Municipal Technical School, Manchester, on Friday, the 20th inst. Full particulars may be obtained from the secretary.

A solution of copper carbonate in ammonia is recommended as a means of blackening brass work. The tints produced are finer and more brilliant than those produced by sulphurising. The colour depends on the kind of brass: those kinds which contain tin give a grey.

In order to remove a coating of nickel which does not adhere well, M. P. Dronier recommends that the article be plunged in an oxidising liquid composed of bichromate of potash, sulphuric acid, and water, in the proportions ordinarily used in batteries. The article should be taken out and washed when ready, and, if necessary, repolished.

An issue of the new coinage may be expected within the next two months. The half-crown, obverse and reverse, is entirely Mr. Brock's, and his, too, are the obverses of all the other coins, which will, as heretofore, bear the imprint of Her Majesty's features. The other coins to have new reverses are the half-crown and the shilling, from designs by Mr. Poynter, R.A.

On the 11th inst. there sailed from Belfast the gunboat "Gorronammah," the first war vessel of the Liberian State. The "Gorronammah" is not armour-plated, and is intended for service on the West Coast of Africa. She is armed with Nordenfeldt guns, of the quick-firing type. Her present crew are white, but these, with the exception of the commander, the chief engineer, and the English gunner, will be replaced by natives when she reaches her destination. The gunboat is exactly like a yacht, her lines being very fine, and her appearance very handsome.

The Southern Mahratta Railway Company, India, have agreed to test the Pintsch Patent Lighting Company's system of lighting railway carriages by means of oil-gas. The experiment will be made on six of the Southern Mahratta Railway bogie carriages running between Poona and Bangalore. As the receiver attached to each carriage will be capable of containing a supply of gas sufficient for 48 hours' consumption, it will be possible to make a trip from Poona to Bangalore and back before the stock becomes exhausted. The trial of the Pintsch oil-gas on the Bombay, Baroda, and Central India Railway still continues, and it is considered not unlikely that this system of lighting will be definitely adopted.

The Ferris Wheel Company have contracted with the Detroit Bridge and Iron-works for the erection of a decided novelty in the amusement line, which will be a feature of the World's Fair. It is a huge iron and steel wheel, 250ft. in diameter. It is to revolve on a shaft resting on two towers, each of which is to be over 125ft. high. The circumference of the wheel is to be a series of cages arranged for the accommodation of passengers. When the wheel revolves the passenger is gradually raised from the ground to a height of 250ft. in the air. The wheel will be turned by electricity. There will be seating capacity for 2150 persons. The construction of this wheel will be very interesting from an engineering standpoint.

Sir Lowthian Bell calculates that not less than 7,000,000 tons of coal are used every year in the gasworks of the United Kingdom. If all this amount were made to yield its ammonia, more than 60,000 tons of the sulphate—so valuable as a stimulant of vegetable life—would be produced, worth, at less than half its former price, about £600,000 a year. To this sum has to be added the value of the tar. Besides this some 15,000,000 tons of coal are annually coked for the use of our iron-works in ovens where the gas is burnt under conditions which preclude the possibility of any tar or ammonia being rendered available. Until some ingenious person shall show how to dispense with these wasteful processes, an annual loss of sulphate of ammonia is incurred which is reckoned to be worth considerably more than £1,000,000 sterling.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

POOLE'S GRINDING MACHINE FOR LATHES.—Required, the address of makers of this machine,

FILTRATION.—Will any reader state the best method of filtering 150 gallons of canal water per day for steam-boiler purposes?—T. H. MITCHELL.

SQUARE SHAFTS FOR CRANES.—I shall be glad if any reader can give me the names of any firms who make a specialty of large square shafts for cranes.—INQUIRER.

TWIST DRILL CUTTERS.—Can any reader give me a method of getting the correct thickness and shape of cutter for any diameter of twist drill, straight lip? A drawing will greatly oblige.—J. M. F.

"GRASS" PACKING.—Can any reader supply me with the address of manufacturers of this packing? I have seen it used for the piston and valve rods of L. and N.-W. railway engines.—LOCO.

SPEED CONES.—I have a speed cone, the diameters of which are 19¾in., 18½in., and 9in. I want the 18½in. to drive a 7in. pulley. Will some one give me a rule for calculating the diameters of the other two pulleys?—W. S. M.

CORROSION IN GAS ENGINE JACKET.—We have a gas engine, and find, when we draw water out of cylinder jacket, that it is quite muddy with corroded iron. Can anyone inform us how to stop this corrosion?—W. W. AND SONS.

BLOWERS v. FANS.—Will any reader supply me with some reliable data for calculating the power required to drive blowers and fans? I would also be glad of an opinion with regard to their comparative merits in blowing blacksmiths' fires.—POWER.

GRINDING VALVES.—Will any reader advise me as to the best means of scouring brass valves and seats to a smooth face? I have tried flour emery, and a fast speed, but as I get at times different mixtures of metal in the valve and seat, I cannot smooth them both together.—W. THOMAS.

LOSSES IN STEEL FURNACES.—Could any reader kindly inform me the average per cent. of actual loss, and the average per cent. of skull, in the charge of a Siemens open-hearth steel furnace working charges of from 30 to 40 tons? And also the percentage of loss in heating slabs and ingots in the Siemens regenerative gas furnace?—J. R. R.

STRESSES IN BEAMS.—(1.) What is the shearing force and bending moment at the fixed end of a bracket whose length is 14ft., and which carries one ton at the free end and two tons at 4ft. from that end? (2.) A beam of 20ft. span, supported at both ends, carries a weight of 6 tons at 5ft. from one support, and another of 7 tons at 8ft. from the same support. Calculate the reactions at each support, and the bending moments at each load.—R. B.

WINDING ENGINE.—What weight would a pair of 36in. cylinder engines by 4½ft. stroke raise from a pit with a spiral drum, commencing at 14ft. and finishing at 18ft. diameter, one side to wind from a depth of 350yds. and the other side from 400yds.; ropes to be 1½in. diameter, boiler pressure 80lb. per square inch, cut-off at ¾ stroke? What weight would the above engines raise from a depth of 280yds., with a flat rope drum, commencing at 12ft. diameter; sizes of ropes 5½in. by ⅝in. (steel)? What would be the rise in inches per yard of a slant whose angle is 26 degrees?—MINER.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

A. H. S.—No address given.

GROOM.—Try a solution of nitric acid.

J. WRIGHT.—Thanks for your letter. We will procure a copy of the work.

ONE IN A FIX.—Apply to Messrs. Buck and Hickman, Whitechapel-road, London.

H. RANSON.—(1.) Yes, we should rather think it would. (2.) Your other queries are quite unintelligible.

R. G. D.—We have not heard of any book on the steam questions of the Science and Art Department.

A. J. J.—Apply to Messrs. Henry Jenkins and Sons, Unity Works, Vittoria-street, Birmingham.

READER.—The subject has been fully dealt with in previous issues. See our issue for April 26, 1890.

TOOLMAKER.—Apply to the Secretary, Commercial Department, Board of Trade, Whitehall, London, S.W.

J. P.—We believe the L. and N.-W. Railway's engine "Cornwall" has the largest driving wheel (8ft. 6in.)—at any rate, so far as narrow-gauge engines are concerned.

E. B.—(1.) There is no satisfactory method of automatically feeding so small a boiler. (2.) Box's treatise on "Heat," 12s. 6d., should suit you. It may be had from our office.

CONSTANT READER.—We would advise "First Principles of Mechanical Engineering" (3s. 6d.) and the "Modernised Templeton" (6s.), both of which may be had from our office.

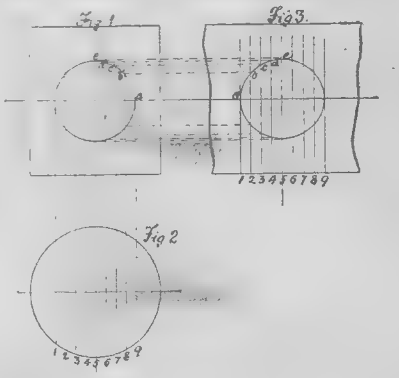
E. MARCH.—We do not know if the counters referred to are sold in this country, but would advise you to inquire for same of Messrs. Charles Churchill and Co. Limited, 21, Cross-street, Finsbury, London.

FORGINGS.—There is no doubt that the deposit is caused by sulphur and other impurities in the fuel. Sand is used for the purpose of combining with impurities in the metal, which requires to be separated from the metal in welding.

G. M.—The gear has a very good reputation, especially on the Continent. Considering the somewhat complex arrangement, it is fairly durable, while it is quite capable of controlling engines subject to great fluctuations of load. It is certainly more economical than slide valve gear.

JACK.—(1.) The thermometer will register 281° F. You can obtain some indications of the latent heat in steam by comparing the time taken to boil a given quantity of water with that taken to evaporate it, the supply of heat being uniform. (2.) Find the circumference of the inside diameter of the tube. This you will find from "The Mechanical World Pocket Diary" (p. 147) to be 0·3927in. Then multiply this by the length (6in.) and by the number of tubes (19), and you have 44·75 sq. in. as the area.

S. C.—Referring to the accompanying sketch, Fig. 1 shows the circular flue with the round hole; Fig. 2 is a plan of same, the distance 1 to 9 representing the diameter of the hole. Divide 1 to 9 into a number of equal parts, as shown, and raise perpendiculars, cutting the elevation of the hole in the flue. Fig. 3 represents a portion of the developed plate, and to



determine the shape of the hole proceed as follows:—Set off a number of divisions, as 1, 2, 3, 4, Fig. 3, equal to those corresponding in Fig. 2, and raise perpendiculars, as shown. From the points where the ordinate 2 (Fig 2) cuts the circle in elevation, draw a horizontal line until it cuts the ordinate 2 in Fig. 3, this giving point in the required curve. Treat the other points similarly, and you will obtain sufficient points through which to draw the curve.

FRENCH AND ENGLISH WEIGHTS.—Can any reader inform me of a work converting tables of weight per millimetre into English pounds per metre run?—ANGLO-METRIC.—A.—I do not quite understand this query, but the following may be of some use:—1 millimètre, 0·03937in.; 1 metre, 39·3708in.; 1 gramme, 0·00221b.; 1 kilogramme, 2·2046lb.—T. MANWARING.

WHEELS FOR MILLING MACHINES.—I thank "J. H. P." for his answer. The machine is a universal milling machine with a spiral head. The tangent wheel has 40 teeth, the worm has a single thread. The feed screw has four threads per inch on one, and five per inch on the other. I want to know if there is a standard number to work my own change gears out for wheels, gears, or anything I may want. I would also like to know how to find the angle of a spiral by calculations. "J. H. P." says there are two small handbooks—one by E. Holden and the other by J. Broadley. Will he tell me which he thinks is the best of the two, and the price?—TOOLS.—A.—In my reply in the issue of the 16th ult. I gave a number of change wheels. These wheels would be suitable for a heavy gear-cutting machine or wheel-moulding machine with a tangent wheel of 180 or 240 teeth, but would not be suitable for a universal milling machine with a tangent wheel of 40 teeth, as in the case of "Tools"; neither would the handbook by J. Broadley or E. Holden be of much service to him. These works treat on the large dividing engine or moulding machine. I have not seen Hasluck's work, at 12s. 6d., as advocated in the issue of the 23rd ult., but probably this may be a work of much service, as the ordinary dividing engine and the universal are two widely different machines. If "Tools" wishes to accomplish all he states, it would well repay him to get "Modern Machine Shop Practice," by Joshua Rose; he would probably be able to obtain this through THE MECHANICAL WORLD Offices. Pending his obtaining other information from either Hasluck's, Rose's, or some other source, I will give him the rule for working out change gears—as a gear-cutting machine—with a tangent wheel of 40 teeth, as is the case with the machine which "Tools" has. Wheel cutting: In order to find the change wheels for a universal milling machine having a tangent wheel of 40 teeth, with single worm, it must be remembered that in wheel cutting the case is just contrary to screw cutting. The number of teeth in the wheel to be cut represents the denominator of the fraction, and the number of the tangent screw wheel the numerator of the fraction. It therefore follows that the numerator represents the division plate, or the division plate wheel, as the case may be, and is called the driving wheel; and the denominator represents the tangent screw, or the tangent screw wheel, as the case may be. Some universal machines are supplied with three different division plates, with different numbers of holes drilled in at equal distances apart; others are worked with wheels, hence the distinction, division plate and division plate wheel. *Example* 1.—Required the number of holes to move in division plate, or number of wheels on division plate and tangent screw shaft to cut a wheel of 90 teeth:—

$\frac{40}{90} \div 3\frac{1}{3} = \frac{12}{27} \times 1\frac{1}{3} = \frac{16}{36}$; move 12 holes on No. 27 division plate, or 16 holes on 36 division plate; in the case of wheels, 12 teeth on handle shaft, 27 on tangent screw shaft, or 16 and 36. *Example* 2.—Required the movement in division plate for wheels to cut 165 teeth:—

$\frac{40}{165} \div 5 = \frac{8}{33} \times 2 = \frac{16}{66}$; move eight holes in 33 division plate, or 16 holes in 66 division plate, or one turn of handle with eight teeth on handle shaft and 33 teeth on tangent screw, etc. *Example* 3.—Required the movement in division plate or wheels to cut 11 teeth:—

$\frac{40}{11} = 3\frac{21}{33}$, or three turns and 21 holes in 33 division plate, or one turn of handle with 40 teeth in wheel on handle shaft, and 11 teeth in wheel on tangent screw shaft.—J. H. PILKINGTON.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

2nd January, 1893.

1 APPARATUS for INDICATING NAMES of STATIONS in MOVING VEHICLES. G W Robertson.
2 RAILWAY CHAIRS. H T Tallack.
5 MOVABLE SPANNER. C Neil.
7 STOPPERS for LADLES USED for CASTING STEEL. J Stranaghan.
9 WATER CIRCULATOR and FUEL ECONOMISER for STEAM BOILERS. W Kenham.
11 WORKING SIGNALS, POINTS, and SWITCHES of RAILWAYS. C Christmas.
13 ADJUSTABLE BEARINGS for CARRYING SHAFTING. G and E Smith.
14 APPARATUS for MOISTENING AIR. A Shiels.
15 HEATING BUILDINGS, RAILWAY TRAINS, ETC. A Shiels.
17 APPARATUS EMPLOYED in the MANUFACTURE of IRON and STEEL. S D Williams and W J Clapp.
18 PETROLEUM and OTHER MOTOR-ENGINES. S Griffin.
21 BOLTS, STUDS, and NUTS. E C Peck.
24 PROCESS for PRODUCING WELDLESS HOLLOW OBJECTS DIRECT from a SOLID BLOCK.* J Wüstenhöfer and W Surmann.
25 HANDLES of STEAM and HOT WATER COCKS.* J A and S Fletcher.
26 HYDRAULIC MOTOR. C J Eyre.
30 MEANS for UTILISING the POWER of the SEA. C S Snell.
35 APPARATUS for the MANUFACTURE of ILLUMINATING GAS from MINERAL OILS. J Laing.
36 ELECTRICAL INDICATORS. F Villiers-Stead.
40 MACHINERY for TURNING or FACING SMALL ARTICLES in METAL. C J Hewitt.
43 HYDRAULIC MACHINERY. C Christiansen.
45 PREVENTING COOLING and CONDENSATION of STEAM in CYLINDERS, ETC. E Natanson.
50 APPARATUS for SCALPING, SIFTING, or GRADING in FLOUR MILLS. C Walker.
54 EVAPORATION of LIQUIDS. R Sickel.
58 MACHINES for CARVING WOOD. A H Tyler and J S E de Vesian.
61 PREVENTING CORROSION of PROPELLER SHAFTS. W Dumlin.
64 GAS GENERATORS.* L Bénier.
68 GRINDING MILLS. P J Neate.
69 AUTOMATIC TIME STAMPS. E P Baird.

3rd January, 1893.

78 ELECTRO MAGNETS.* R Varley, jun., and F C Jones.
82 MANUFACTURE of MANGANESE and MANGANESE ALLOYS FREE from CARBON.* W H Greene and W H Wahl.
90 MILLING MACHINES.* A G Brookes. (*J Becker*, United States.)
91 FILTERING MATERIAL for USE in the FILTRATION of WATER, the FILTRATION of the EFFLUENT from SEWAGE PRECIPITATION WORKS, ETC. F M and D D Spence.
95 WINDMILLS for SUPPLYING MOTIVE POWER for MINING and AGRICULTURAL PURPOSES.* R Matthews.
98 MACHINERY for MAKING BRIQUETTES or BLOCKS of COMPRESSED FUEL. A E N Yeadon and W Nevins.
100 SAFETY VALVE for WATER GAUGE FITTINGS. W Garner.
105 FACILITATING the STARTING of TRAMCARS. T A McKee.
106 APPARATUS for SHOWING to PASSENGERS the NAMES of the NEXT STOPPING STATION. W Patterson.
108 DOUBLE CYLINDER GAS or OIL MOTOR ENGINE. J Fielding.
109 APPARATUS for SUPPLYING GAS or OTHER FLUID on PREPAYMENT. J Hawkyard and J Braddock.
122 FASTENINGS for SECURING METAL ARMS or BRACKETS to TELEGRAPH POLES. Siemens Bros. and Co. Limited and G W Perry.
123 OVERHEAD REGENERATIVE GAS LAMPS. I J Collins.
124 INCANDESCENT GAS BURNERS. O Imray. (*J Moeller*, France.)
125 APPARATUS for HEATING, EVAPORATING, and CONDENSING. A and F Normandy.
128 DRAUGHT REGULATING APPARATUS for STEAM FURNACES. C A Allison. (*J* and *P St. Mary*, United States.)
130 FURNACES for HEATING STEEL INGOTS.* W E Koch.
133 OBTAINING ELECTRICAL RESISTANCES. H N Lawrence.
136 STEAM and OTHER ELASTIC FLUID ENGINES. M H Robinson.
137 PIPE COUPLINGS. J E Howard.
138 DUMPING WAGONS.* H H Lake. (*W A Thacker*, United States.)
140 STORAGE BATTERIES.* G W Harris.
141 MACHINES for TRUING ROLLS.* D J Davidson and others.
142 DUMPING WAGONS.* H H Lake. (*W A Thacker*, United States.)
145 SEPARATING, by HIGHLY-COMPRESSED AIR, FLUID from SOLID SUBSTANCES.* J Y Johnson. (*A Bornholdt* and *J Glatz*, United States.)
147 SAFETY STOP APPARATUS for MINING CAGES.* W Albrecht.
148 BELT TIGHTENERS and ARRANGEMENT for DRIVING CUTTER SHAFTS of PLANING and MOULDING MACHINES. J B Noble and J B Hensley.
153 VARYING the STRENGTH of the EXPLOSIVE CHARGE or the RATIO BETWEEN the CONSTITUENTS of the GAS and AIR MIXTURE in GAS ENGINES.* G Wetter. (*The firm of Gerson and Sachse*, Germany.)
154 PUMPS. L Motte.
155 ROTARY ENGINES and PUMPS. L Legendre.

4th January, 1893.

157 FLOORING in IRON and STEEL. S D Williams and G C O Wood.
158 VALVES to SHUT OFF the ESCAPE of STEAM or WATER on the BURSTING of a PIPE. J Wishart.
161 CALCULATING MACHINE. J Williams.
167 PRESSES. J Bates.
169 FLUID PRESSURE REDUCING VALVES. H Hocking.
172 ARC LAMPS. R Kennedy.
177 COCKS or VALVES for WATER, GAS, or STEAM. J L Dubois.
185 RAILWAY STATION INDICATOR for USE in RAILWAY CARRIAGES. J Cochrane, jun., and J P Cochrane.
192 COUPLING for HOSE and OTHER PIPES. J M'Farlane and D Robertson.
196 RAILWAY SIGNALLING DURING FOGS.* B T Giraud.
197 HOT WATER BOILERS. C Whitfield.
198 BRAKE MECHANISM for WAGONS. W H Eagleson.
199 FLOUR MACHINERY. E Redler.
200 TRANSMITTING POWER to the DRIVING WHEELS of GEAR-DRIVEN LOCOMOTIVES for USE on ROADS or RAILWAYS. B J Diplock.
206 APPARATUS for PRODUCING LIGHT by MEANS of ALTERNATING ELECTRIC CURRENTS. Sir D L Solomons, Bart, and L Pyke.
210 SUCTION APPARATUS to be USED in REVOLVING STRAINERS for STRAINING PULP for PAPER-MAKING MACHINES. J Hyde, jun.
215 MACHINERY for the MANUFACTURE of PAPER BAGS.* A J Denoyer.
217 CLUTCH or RATCHET DEVICES.* B Ljungström.
220 CASH REGISTER and ADDING MECHANISM. W W Horn. (*J E Claudin* and *P Rohert*, United States.)

5th January, 1893.

225 STOVING and DRYING MACHINERY. G V Priestley.
229 DYNAMOS. H G Read.
231 GAS REGULATORS. W Defries and V I Feeny.
236 ELECTRIC RAILWAY SIGNAL for USE in FOGS. A Smethurst.
239 BELT FASTENER. P Pailloux-Michel.
242 SEXTANTS WITH ARTIFICIAL HORIZON.* S H James.
244 PICKLING and SCRUBBING of IRON and STEEL SLABS, PLATES, WIRE COILS, ETC. W S Rawson and Woodhouse and Rawson United Limited.
246 CASTING FRAMES or SUPPORTS for ELECTRIC BATTERY PLATES or ELEMENTS. E W Timmis.
250 SIGNALLING. E S Higgins and H C Jenkins.
257 APPARATUS for INSULATING ELECTRIC WIRES. R E B Crompton and H J Dowsing.
258 APPARATUS for USE in the APPLICATION of ELECTRICITY for HEATING LIQUIDS. R E B Crompton and H J Dowsing.
260 EXPANSION GEAR for FLUID PRESSURE ENGINES. T Walker and G F Alder.
269 JOINING RAILWAY RAILS, and FISH-PLATES THEREFOR. L R Gillanders.

6th January, 1893.

272 FASTENING BOILER TUBES INTO TUBE-PLATES. G Wilson.
282 AIR PROPELLERS. W Tattersall.
283 AIR PROPELLERS. W Tattersall.
284 APPARATUS for HUMIDIFYING AIR. W Tattersall.
285 PIPES or TUBES. R D Smillie and W C Wallace.
302 HEATING STEAM BOILERS by MEANS of a FLAME DEVELOPED INSIDE the BOILER. O Brünler.
303 CAR MOTORS. G Stevenson.
318 SIGNALLING on RAILWAYS in FOGGY or SNOWY WEATHER. J F Outtram.
320 SURFACE BLOW-OFF or EXHAUST DEVICES or SCUM PIPES. J M'Callum.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to SIR H. READER LACK, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

The Mechanical World

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FRIDAY, JANUARY 27TH, 1893.

Tramways in the United States.

SOME interesting particulars are just to hand concerning the great development which is taking place in the matter of street railways in the United States. The figures are for the year 1892, and they are remarkable from the fact that the use of horse cars in the States is being rapidly discontinued in favour of mechanical traction. The mileage of lines worked by horse cars at the end of last year was 4460 miles, being a diminution of no less than 842 miles as compared with the close of 1891. On the other hand, electric tramways, which are superseding so quickly the system of horse haulage, reached a total length of 5939 miles, or an increase over the previous year of 1878 miles. This great augmentation is of course partly accounted for by the substitution of electric for horse cars, and partly by the laying down of new lines. Cable lines also showed an advance, the mileage being 646 as against 594 miles in 1891; whilst the length of the tramways operated by steam decreased from 642 to 620 miles. It will be seen that these figures give a grand total mileage of all systems of 11,665 miles, and that the increase in length over 1891 is 1066 miles. Somewhat similar results will be found in the number of cars in use, which diminished or increased according as different methods were adopted, but which on the whole showed an advance of 1522 cars, the total number in use being 37,399. Truly these are remarkable results. They demonstrate, in fact, the great confidence reposed in electricity as a motive power, and which is rapidly superseding other systems. The days of the horse car in the United States are numbered; steam traction on tramways is not held in high favour, and is for hat and commercial reasons losing ground. Cable cars are suitable where, with our present knowledge, electricity would not yield such good results; whilst electricity, where 10 years ago there was scarcely a single line in existence, leads the way with the enormous mileage of 5939 miles of lines, or over six times the length of the total tramway mileage in the United Kingdom.

Electricity in Ironworks.

A RATHER extended application of electricity in mining and metallurgical works is about to be made by the Schalk Mines and Foundry Company, of Gelsenkirchen. The company propose to have erected in their extensive works a generating station for the electric lighting of the establishment, and for the operation of the plant. No less than twenty electromotors of a total capacity of 300 H.P. will be put down at the commencement. They will be used for driving pumps, heavy machine tools, and three large cranes. The station will be equipped on the Lahmayer system, and will be one of the largest of its kind in Europe.

Lloyd's Shipbuilding Returns.

FROM the returns issued by "Lloyd's Register of Shipping," it appears that, excluding warships, there were 306 vessels, of 570,741 tons gross, under construction in the United Kingdom at the close of the quarter ended December 31. Of these 207 were steel steam vessels of 500,440 gross tonnage; thirteen iron steamers of 5850 tons; seven wood and composite steamers of 484 tons; thirty steel sailing ships of 59,705 tons; two iron sailing ships of 530 tons; and thirty-eight wood and composite of 3724 tons. Comparing the present returns with those published for the quarter ended September, a decrease is observed in the tonnage of vessels under construction of about 110,000 tons. The September returns were less than those for the June quarter to the extent of nearly 100,000 tons, and these again were less than the March returns by almost 70,000 tons. It will thus be seen that since March last the work in hand has diminished by over 32 per cent. The construction of sailing tonnage reached its highest level during late years in December last, when the returns showed 198,405 tons in hand, or more than 130,000 tons in excess of the present figures. Proportionately to the total work in hand, the highest point was attained in September, 1891, when the sailing tonnage formed over 26 per cent.; now it forms little more than 11 per cent. The new vessels ordered, but not commenced, which at the end of 1891 were 98, of 207,601 gross tonnage, were at the end of 1892 but 56, of 125,179 tons, or only a little more than half the number. Of the total number under construction, 222, of 444,187 tons, are for the United Kingdom, and six, of 3750 tons, for British Colonies.

An Electric Rack Railway.

THE long talked-of problem of traversing the Simplon, in Switzerland, is proposed to be carried out in a remarkable manner. The new scheme, which was brought before a meeting of Swiss bankers at Geneva last week, is due to Mr. Masson. It comprises the construction of a rack railway on the Riggenbach system, and with electricity as the motive power instead of steam. Full details of the scheme were put before the meeting, and the cost of the projected line is estimated at £1,600,000, whilst four years would be required to complete it. It is said that the scheme was favourably received, and that a large portion of the capital necessary to build the line would be provided by the Geneva bankers, who hold 100,000 Jura-Simplon shares. If the line is constructed the length of route between Milan, Genoa, Belgium, and England would be greatly diminished.

Iron Sleepers.

THE question of extending the use of iron sleepers on German railways, instead of employing wooden sleepers obtained from abroad, has, it is said, been well received in the circles of the State Railway Administration. A decision has not yet been arrived at, the kind of bedding to be used playing rather an important part in the matter. The Imperial Railway managements have therefore been induced, as a preliminary step, to ascertain whether, and to what extent, difficulties exist in their districts against a greater use of transverse iron sleepers. Longitudinal iron sleepers have, it will be remembered, proved not sufficiently durable. The wooden sleepers are very largely purchased from abroad, and it was mainly with a view to give employment to German works that the State Railway Administration was approached on the matter, which has yet to be well considered.

Electric Cranes.

ATTEMPTS are being made by some of the American engineering journals to discount the all-round utility of the electric crane. It is being considered questionable whether the electric crane is really an advance upon the older systems, while it is insinuated that its rapid introduction is due to its novelty and popularity rather than to real superiority. The doubters appear to rest their case upon the crane at the Watervliet Arsenal, which, when recently tested, gave an efficiency of from 20 to 60 per cent. We think, however, that in comparing electric with hydraulic, rope, or shaft-driven cranes, it is unfair to credit the electric system with the first cost of a separate engine, since a dynamo can be driven from the main shafting just as well as a rope or shaft. Of course the first cost of the electric system will be greater, but this is not necessarily a defect. Then, again, in taking the all-round efficiency of the crane into account, it must be remembered that for the greater part of the time the crane will be idle, although it must always be in readiness, so that against the power required to continuously drive a rope or shaft there is to be set that necessary to keep the dynamo running up to speed. The latter amount is obviously much less than the former, so that this is another point in favour of the electric system. All things considered, we are inclined to think that our American contemporaries have been in too great a hurry to disparage the electric crane.

Electric Lighting in the West End of London.

ELECTRIC LIGHTING is greatly progressing in the Metropolis, as is shown by the considerable augmentation in the number of lamps now in use as compared with that obtaining about a year and a half ago. Then the number barely reached 200,000, whereas now there are over 500,000 incandescent lamps connected with the mains of the various electric-light companies. The St. James's and Pall Mall Company, whose annual meeting takes place this week, has now practically completed its new central station in the northern part of the district over which it has Parliamentary powers. This station already contains plant capable of supplying current to 20,000 lamps of 8 C.P., and its capacity, when necessary, can be raised to 65,000 lamps. The two stations are already connected by the existing great trunk main, and they will shortly not only be able to run concurrently, but will also be able to relieve each other should necessity arise. At the same time, it is worthy of note that the plant at the southern central station fully maintains the efficiency and economy noted last year, and has produced an income of about £34,000. It is also noteworthy that although the company was unsuccessful in the action brought against it by Dr. J. Hopkinson, and to which reference was made in our last issue, arrangements have been completed whereby the supply of current can be continued without interruption and without the use of the patentee's system. This is a satisfactory state of affairs for the company, but more so is the distribution to the shareholders of a dividend at the rate of 7½ per cent. per annum on the ordinary shares.

Employment in the Engineering Trades.

THE reports issued for the first month in the year by the trade union organisations connected with the engineering industries are no very reliable indication of the actual condition of employment, as the returns of out-of-work members include the temporary suspensions which always take place for the holidays and usual stocktakings, and they thus show an exceptionally large percentage of members in receipt of out-of-work support. But though the returns would thus be misleading as to the actual condition of employment, they afford an indication as to the condition of trade, as the number of suspensions and the period over which they extend are very much regulated by the state of the order books at the various works. The suspensions this year have not only in number been considerably above the average, but in most cases they have extended over longer periods than usual, and this may be taken as pretty strong proof that as a rule there is no actual pressure of work in hand, or just now in prospect, throughout the engineering industries. In the Steam Engine Makers' Society the returns of members in receipt of out-of-work support increased to 5½ per cent. of the total membership, and in the Amalgamated Society of Engineers there would be about double this percentage temporarily on the books in receipt of out-of-work support. The men who were suspended during the holidays have, however, during the past week been gradually getting back to work, but in the Amalgamated Society of Engineers there is still about 8 per cent. of the members in the Manchester district—where the stoppages have especially been more extended than usual—on donation benefit, and the exceptional depression of the locomotive-building trade has thrown an extra number of out-of-work members on the books. With regard to the outlook of trade generally, the reports from the various districts show no material change; but if there is no improvement the condition does not get any worse, and in one or two shipbuilding centres is perhaps rather better.

Institution of Mechanical Engineers.

THE forty-sixth annual general meeting of this institution will be held on Thursday evening, February 2, and Friday evening, February 3, at 25, Great George-street, Westminster, by kind permission of the Council of the Institution of Civil Engineers. The chair will be taken by the president, Dr. William Anderson, F.R.S., at half past seven p.m. on each evening. The following papers will be read and discussed:—"Description of the Experimental Apparatus and Shaping Machine for Ship Models at the Admiralty Experiment Works, Haslar," by Mr. R. Edmund Froude:—Principal features of present works at Haslar and former at Torquay. Water-way and experiment carriage. Stationary engine and hauling gear; governor. Model-shaping machine; principal differences from original Torquay machine. Adjustable level of cutters; lateral motion of cutters. Drawing table, position, and size; copying apparatus. Travel of model. Melting and casting of paraffin for models. Steelyard weighing machine. "Description of the Pumping Engines and Water-softening Machinery at the Southampton Water Works," by Mr. William Matthews:—Pumping engines at Mansbridge and at Otterbourne. Cylinders, valves, and surface condensers, etc. Beams, shafts, and flywheels. Pumps, low-lift and high-lift. Boilers. Cost of pumping. Engine trials. Water-softening apparatus; cream of lime, lime water, filtering. Cleaning of filters. Cost of softening.

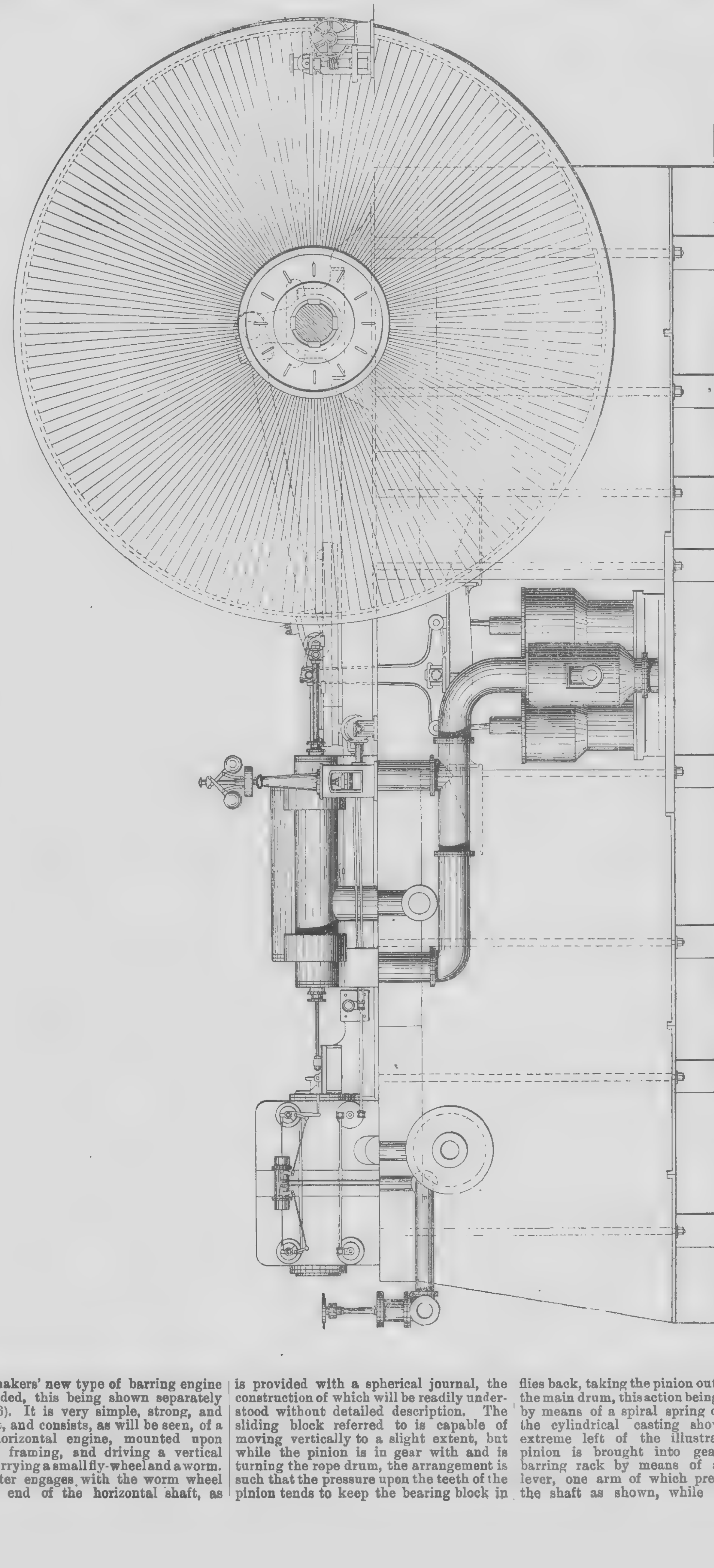
DR. RICHARD JORDAN GATLING, it is stated has improved upon the revolving battery gun which bears his name. Hitherto electricity has not been applied successfully to firearms, but the new Gatling gun, we understand, will, by means of an electric motor, be able to fire 2000 shots a minute, or more than 33 every second.

1700 I.H.P. Triple-expansion Mill Engines.

The economical development of power in spinning and manufacturing concerns has of late years been increasingly recognised as an indispensable condition of successful working, and as a consequence we now find millowners and manufacturers anxious to avail themselves of the latest advances in steam engineering in order to reduce expenditure as much as possible in this direction; hence the general adoption of the multiple-expansion engine for the driving of mills and manufactories. As to the profitable limiting number of cylinders, opinion is at the present time exhibiting some differences; but there appears every reason to believe that the triple-expansion engine, under existing conditions, best satisfies the required conditions of economy, steady running and durability, combined with moderate first cost. The most recent practice in mill driving certainly tends to support this view, for quite a number of triple-expansion engines have been constructed latterly for this service.

We have on the present occasion the pleasure of bringing before the notice of our readers a very fine set of triple-expansion engines made for the Ellen-road Spinning Company's mill, Milnrow, near Rochdale, by the old-established firm of Messrs. J. and W. McNaught, St. George's Foundry, Rochdale. As will be seen from the accompanying illustrations, two low-pressure cylinders have been adopted, one of these with the high-pressure and the other with the intermediate cylinder, forming a pair of tandem engines, working on to cranks at right angles, and with the rope drum between them. This arrangement has several points of merit. It is true that it necessitates the use of another cylinder, piston, and valve gear; but, on the other hand, it has a compensating advantage, inasmuch as for the relatively large low-pressure cylinder two very much smaller ones are substituted, and not only is the general design and appearance of the engine considerably improved in consequence, but also the power transmitted through each crank in this way rendered approximately equal, thus conducing to smooth running and regular turning—advantages, we need scarcely say, which are of the first importance.

In the engine under notice the high-pressure cylinder is 24½in. in diameter, the intermediate cylinder 38½in., and each of the two low-pressure cylinders 43½in. in diameter, the stroke being 6ft. With a boiler pressure of 160lb. per sq. in., and running at 55 revolutions per minute, the engine will develop 1700I.H.P. The two low-pressure cylinders and the intermediate cylinder are fitted with piston valves, those on the last-named cylinder being provided with a cut-off arrangement adjustable by hand. By a very simple and ingenious method, all the piston valves are given a twisting motion, with the object of preventing scoring of the valves and seats. The high-pressure cylinder is fitted with Corliss valves, the admission and exhaust valves being actuated by separate eccentrics. The trip gear is exceedingly simple, light, and effective, and is controlled by a cross-armed weighted governor, as indicated. A large jacketted receiver is provided between the high and intermediate-pressure cylinders, as shown in plan. This is fitted with an intercepting plate and steam trap to thoroughly separate all entrained water from the steam. The low-pressure piston rods are 6½in., and those for the high and intermediate-pressure cylinders are 5in. in diameter; the crank pins are 10in. in diameter and 11in. in length. The crank-shaft is 16½in. in diameter, 32in. long in the bearings, and is swelled to 22in. in diameter at the wheel seat. The shaft pedestals are made with the brasses in three pieces, and are capable of being adjusted by means of side wedges and screws. The rope drum is 28ft. in diameter, and is grooved for 43 1⅝in. ropes. It is composed of two sets of arms and segments, and has two bosses or wheel centres 7ft. in diameter. All the joints are carefully machined throughout, and each set of arms is arranged so as to alternate with the other set. The total weight of the drum is about 70 tons. The beds, which are very simple in form, and of massive proportions, are of the box section and 19in. deep; the Corliss cylinder is bolted direct to the end of the bed. Four air-pumps are provided, these being of the makers' patent type, specially adapted for high piston speeds. They are 26½in. in diameter, have a stroke of 28in., and are so arranged as to form two double-acting pumps. Careful attention has been given to the lubricating arrangements, and the engine is provided with an emergency governor which shuts off the steam when the speed becomes excessive. Electrical stopping gear is fitted throughout the mill, this being brought into operation by the breaking of a glass disc. A detector rod in connection with this gear is placed close to the rope drum, so that in the event of any one of the ropes fraying or giving way, the engine will be stopped automatically.

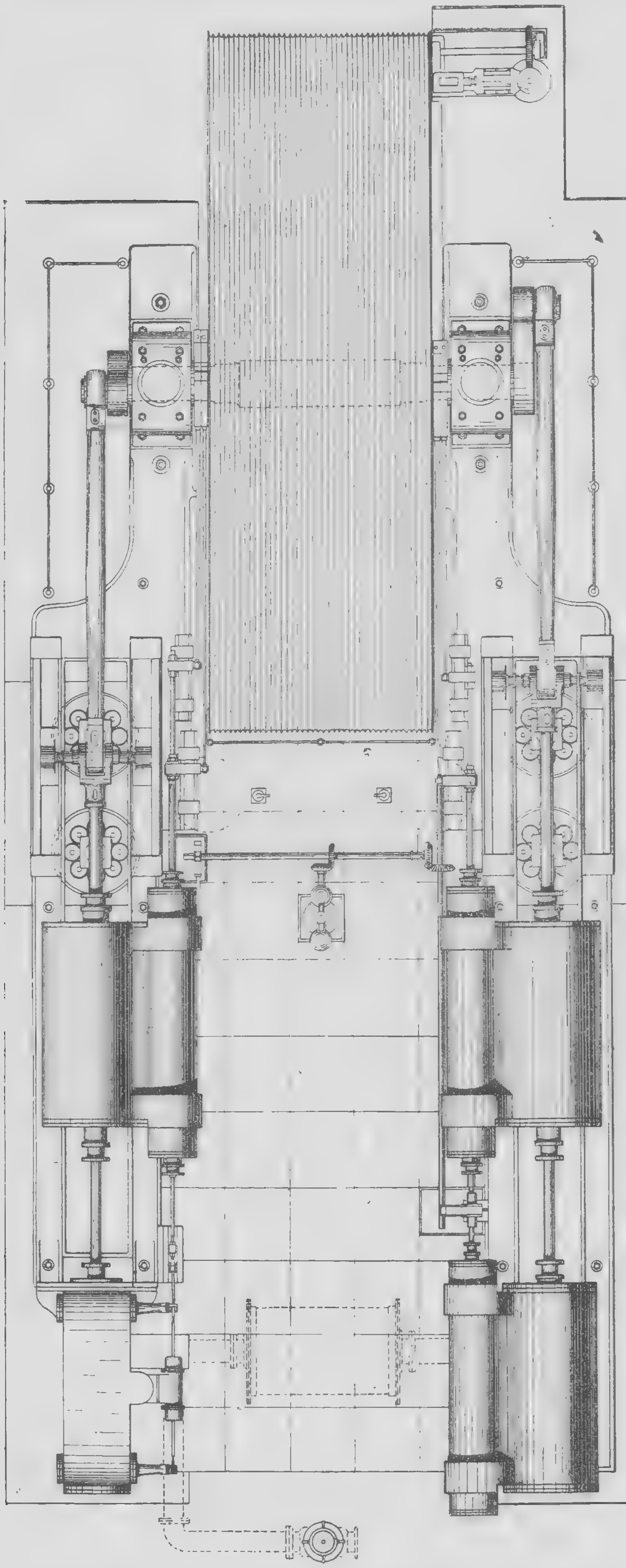


1700 I.H.P. TRIPLE-EXPANSION MILL ENGINES.—SIDE ELEVATION.

The makers' new type of barring engine is provided, this being shown separately (page 36). It is very simple, strong, and compact, and consists, as will be seen, of a small horizontal engine, mounted upon suitable framing, and driving a vertical shaft, carrying a small fly-wheel and a worm. The latter engages with the worm wheel on one end of the horizontal shaft, as shown, the other end of which carries the pinion gearing with the barring rack on the inside of the rim of the rope drum. This horizontal shaft is carried at the pinion end in a bearing which is capable of moving to and fro in the slide or way formed in the framing. To allow such movement to occur the other bearing is provided with a spherical journal, the construction of which will be readily understood without detailed description. The sliding block referred to is capable of moving vertically to a slight extent, but while the pinion is in gear with and is turning the rope drum, the arrangement is such that the pressure upon the teeth of the pinion tends to keep the bearing block in contact with the upper surface of the slide, in which position it is locked laterally by means of a steel stop. A flat spring, always tending to lift the sliding block from below, supports the weight of the horizontal shaft. If desired, by lifting the hand lever shown, the sliding block may be depressed, and when once clear of the steel stop or detent, it flies back, taking the pinion out of gear with the main drum, this action being accelerated by means of a spiral spring contained in the cylindrical casting shown at the extreme left of the illustration. The pinion is brought into gear with the barring rack by means of a bell-crank lever, one arm of which presses against the shaft as shown, while the other is

carried to the other side of the engine, and is, with the other levers, readily accessible. It will be understood that so long as the pinion is driving the main drum, the pressure on the teeth is sufficient to keep the sliding bearing block in the upper position; but as soon as the rope drum overruns the barring pinion the direction of pressure upon the teeth of the latter is reversed, and the bearing block is, in consequence, depressed, and becoming clear of the stop, immediately disengages the pinion. It will be seen that, if desired, this action may be caused to operate the steam supply to the barring engine, thus making the apparatus perfectly automatic in action.

We may say that we recently had the pleasure of inspecting several of Messrs. McNaught's engines, and were much impressed with the excellent workmanship bestowed upon them, as well as with the design, both general and detailed. The engines illustrated are in every respect a highly-creditable production, and represent the most recent advances in high-class mill engines.



1700 I.H.P. Triple-expansion Mill Engines. Plan.

An American inventor has introduced an electric sleigh. Current is supplied to the motor by a battery of accumulators concealed under the seat of the sleigh. The power is transmitted to a wheel in front of the sleigh by chain gearing. The face of the wheel is provided with cutters, which embed themselves in the ice or snow, and prevent the wheel from slipping. It is claimed that a speed of from 12 to 15 miles per hour can easily be obtained by these means.

Metal-cutting Tools.

(*Continued from page* 15.)

Milling Cutters. — Milling tools, or cutters, as they are termed, are for use in the milling machine, and consequently belong to the rotating class. They are capable of performing an almost endless variety of work, and for many purposes are far superior to reciprocating tools, such as planer, shaper, etc. There are two general classes—the straight face for plain slabbing, grooving, rebating, etc., and special shapes *ad infinitum.* The latter include gear cutters and grooving cutters, both of which are of standard forms adopted by the different makers. Like taps, reamers, etc., all kinds of milling cutters—except, of course, such special shapes as may not be required for general use—are made specialties of manufacture by a number of large concerns, such as Brown and Sharpe Manufacturing Company, Pratt and Whitney Company, and others. Any unusual shapes are made by them when ordered. Their facilities enable them to produce these goods so much more cheaply than they can be made in the shop that it is generally much better to buy than to make them, particularly as they are extremely risky articles to harden, and may be ruined in this process, after nearly the entire cost of making and material has been incurred, unless the workman is possessed of an unusual degree of skill and experience.

Where it is desired to make them, however, it is best to use the utmost care in the selection of suitable material. Forgings only should be used, as there is too much uncertainty in the physical qualities of round tool steel, unforged, although it is perfectly reliable after being properly rehammered. Careful and thorough annealing is also necessary, not only to render it easily worked, but to ensure the uniformity of structure essential to successful hardening and tempering. While these precautions are very frequently neglected, it is not good practice, and may result in the loss of a much greater amount than the cost of observing them. In chucking the hole, the centring should be accurate, so as to make the amount of metal turned off as nearly uniform as possible. The hole should be made of a size to fit snugly on the mandrel of the milling machine, as the least amount of lost motion will cause the cutter to run out of true, and consequently throw the entire cut on a very few teeth on the high side, while the great majority do not touch the work at all. The effect of this will be to dull the cutting teeth very rapidly, and also to render the surface of the work wavy and uneven, and a bad job generally. It is best, and the usual practice by manufacturers, to slightly chamber the bore, leaving only sufficient bearing at each end to ensure durability of size.

After turning to the required shape, the face which gives form to the cutting edges should be finished perfectly smooth, and the blank is then ready for cutting the teeth. As the making of the tools naturally suggests the possession of a milling machine in which to use them, the fluting should be done by it, though in case of necessity it may be done on a planer or shaper. For all straight-faced cutters the teeth should be spiral, which gives them a draw cut and produces much smoother work than can be made by straight teeth. Of course, the mandrel upon which the blank is turned is placed on the index centres of the machine, which are provided with an adjustable rotating device, actuated in unison with the longitudinal feed. This gives the spiral cut, and the pitch of the latter is varied as required by means of change gears. A table of the different angles suitable for given diameters of cutters and the number of teeth in change gears usually accompanies the machine and obviates the necessity for calculation. In case the machine is not provided with this attachment, the proper spiral may be obtained on the plain index centres used on the shaper by placing a stationary inclined guide, set at proper angle and engaging the teeth of a gear on spindle having the proper number of teeth (or their multiple) to correspond with those of the cutter. The shape of grooves in cutter may be correctly obtained from the standard B. and S. cutter—the latter being set to give a radial face to the tooth on its cutting side.

The depth should not be too great, as, if unnecessarily so, it has the effect of weakening the teeth. In case the standard cutter is not used, it is important to see that a good, perfectly curved fillet is allowed in bottom of groove next to cutting edge. This is necessary, not only as a matter of strength, but to prevent danger of cracking in the hardening. It is a good plan to run two cuts to each groove—the first, or roughing cut, removing the stock, and the second being a very light finishing cut. Of course, the complete circuit of the cutter is made with the first setting before starting the second cut. If the cutter used for the finishing cut be in good order, there will be no necessity for hand work in finishing the grooves, as they will be sufficiently smooth without it. The width of the cylindrical surface left for forming the edges of teeth should be about $\frac{1}{64}$ inch for cutters of $1\frac{1}{2}$ inch diameter and upward.

There is no necessity for any hand work in clearing the edges before hardening, as the operation can be much better done by grinding with a fine wheel afterwards. A very simple and commonly used device for this purpose consists of a mandrel fixed firmly to the frame of the grinding machine and made adjustable as to its distance from the face of the wheel. Its length should be sufficient to admit of the entire length of cutter being passed before the wheel, with an ample allowance for clearance at each end. A fixed guide is adjusted to one of the grooves in the cutter in such a position as to effect the indexing and also to give the necessary spiral motion, corresponding with the angle of the grooves. The guide, at the entering end, is made short enough to allow the cutter to slide entirely clear of it, so as to disengage the finished tooth and enter the next. For cutters of very narrow face, in proportion to the diameter, it is necessary to use a mandrel whose diameter is enough smaller than the bore of the cutter to admit of a long sleeve being snugly driven into it to serve as a bearing. This will prevent the tendency to tilting and ensure true work. A good-sized wheel, of comparatively narrow face, should be used to avoid too much concavity to the clearance face. While different facilities are required to effect it, the clearance grinding will be much better in its results by feeding the work parallel with the plane of revolution of the wheel. There will be no concavity, and the angle of clearance can be made accurately as desired to give the best cutting effect to the edges. A cutter so cleared will do much smoother work, as well as possess greater durability than one done by the first method.

The temper required may be obtained by reheating after hardening only sufficiently to relieve shrinkage strains, and will be indicated by the first appearance of colour—a very pale straw. The peripheral, and not the rotative speed of the cutter, must be considered, and should not be so great as to cause heating of the teeth. For tough metals a lubricant should be used, as it saves the cutter and facilitates its action. For cast iron or hard brass there is no advantage in its use. In manufactured cutters, for all forms of standard-shape work, the teeth are made of greater pitch, and the clearance face carried back as far as the cutting face of next tooth. This, of course, requires that the clearance be perfectly uniform at all points on the back of the tooth, and that the shape of the cutter, as to outline of resultant cut, shall also be continued to the full depth of tooth. The object of this form of cutter is to admit of its being reground as often as necessary without producing any change of shape, the grinding being required only on the radial face of the groove. For gear cutters, especially, it is important that the form remain intact, as the least change from that originally given them will utterly destroy the accuracy of the carefully calculated curves and faces of gear teeth necessary to ensure their proper working.

Standard cutters for all pitches and diameters of gears, of both involute and epicycloidal forms of teeth, are made in this manner, and have become almost universally considered a necessity. For milling any considerable width of surface, composed of a combination of a number of curves, flats, and angles, it is best to have a "gang" of cutters, comprising one for each shape in the combination. They are the same in effect as a single cutter, having a combined profile, and are much more cheaply made and kept in order, besides being individually available for other purposes.

Metal slitting and grooving saws are simply very narrow-faced milling cutters, and should be made and used in all respects as such. As they are somewhat deficient in the matter of strength, the temper should be as low as the nature of the material for which they are used will admit. For brass they may be made quite soft—as low as full purple colour being allowable. Shallow teeth of fine pitch and slight clearance will be both more durable and fast cutting than if made differently. Milling cutters having their working faces at an acute angle or end, instead of on the periphery, should have their teeth cut slightly tangent,

instead of radial, in order to give them the effect of a draw cut like that caused by the spiral edge of flat cylindrical cutters. The faces of teeth should be perpendicular to the plane of rotation, while the clearance on the back is made very slight. Where the teeth are terminated, there should be a recess as deep as the bottom of the grooves, to act as clearance.

Another and radically different form of cutter is sometimes used in milling machines. It is substantially but a modification of the cotter drill—at least, as regards its action, though in form it appears very different. For all except very small sizes it is a shank fitting the chuck or socket of the machine spindle, and a pair of forked points upon which are the cutting edges. The latter, in respect to angle of cut and clearance, are similar to a turning or boring tool. As they are used only for surfacing or straight grooving or rebating, the edges must be in exactly the same plane or the work will be uneven. For surfacing on large work, considerable spread is given to the prongs—as much as 6in. sweep being not uncommon. For many kinds of work the tool is very efficient, being very quick cutting and easily kept in order. For smoothness of finish, however, their work will not compare with that of the cylindrical cutter, as the interlocked circular tool marks are of a nature to be very perceptible to the eye, even when not so to the touch. The foregoing comprise all of the principal tools of the rotative class, and there remain to be considered only those exclusively for hand use. Of these we will briefly consider but three—hand-turning tools, files, and the much-abused hack saw. Of the first-named class, the most important tool is the diamond-point graver.

(*To be continued.*)

Shipbuilding Notes.

The Germania Shipbuilding Company, of Kiel, has declared a dividend of 16 per cent.

The Glasgow and South-Western Railway Company have placed a contract for two fast paddle steamers, for the coast traffic, with Messrs. J. and G. Thomson, Clydebank.

Messrs. Russell and Co. launched from their Greenock yard, on the 18th inst., a steel barque. The dimensions are:—Length, 236ft.; breadth, 36ft.; depth, 21ft. 9in.; 1400 tons net register, and 2400 tons carrying capacity.

Messrs. Charles Connell and Co. launched on the 19th inst., from their Scotstoun shipbuilding yard at Whiteinch, a three-masted steel sailing ship, of about 1820 tons, which they have built to the order of Mr. James Nourse, shipowner, London.

On the 19th inst. there was launched from the shipbuilding yard of Messrs. Scott and Co., of Bowling, a screw steamer. The dimensions of the vessel are 175ft. by 26ft. 6in. by 13ft. Compound surface-condensing engines are being supplied by Messrs. Ross and Duncan, Govan.

Messrs. J. M'Arthur and Co., Paisley, launched from their yard on the 18th inst. a screw-steamer of about 500 tons deadweight. The principal dimensions are:—Length, 142ft.; breadth, 25ft.; depth moulded, 12ft. 2in. Powerful engines, by Messrs. Bow, M'Lachlan and Co., of Paisley, are being fitted, and it is expected that a speed of about 11 knots will be attained.

The majority of the Wear shipyards are very slack at present, but it is stated that Messrs. Short Brothers, Pallion, have just booked an order for a large steamer of 5000 tons deadweight carrying capacity, and with other work in hand, are likely to be kept in active operation for some time to come. The engines for the latter vessel will be supplied by Messrs. William Allan, of the Scotia Works.

Messrs. David and William Henderson and Co. launched, on the 19th inst., from their yard at Partick a large screw steamer. The principal dimensions are:—Length, 377ft.; breadth, moulded, 46ft.; depth, moulded, 31ft. The vessel will be fitted with a set of triple-expansion engines by the builders. These have cylinders 26in., 43in., and 70in. diameter, by 54in. stroke. There are two single-ended boilers, working at a pressure of 165lb.

The Italian battleship which is building at Venice is of a new type, and will have a displacement of 9800 tons, a length of 344ft. 6in., a beam of 69ft. 3in., and an extreme draught of 24ft. 8in. With forced draught she will develop 13,500H.P., and steam at 18 knots speed; with natural draught a speed of 16 knots will be obtained with an expenditure of about 9000H.P. There is an over-all protective deck of steel varying in thickness from 1½in. to a little over 3in. An armoured citadel, in the middle of the vessel, and the armoured belt will carry plates varying from 4in. to 9¾in. thick. At each end of the citadel will be a turret armed with two 9·9in. guns. Elsewhere, with suitable shields, will be mounted eight 5·9in., eight 4·7in., four 2·2in. (6-pounders), and 12 small quick-firing or machine guns. The coal-carrying capacity is to be 1000 tons.

The Resistance of Railway Curves.

(*Concluded from page 270, vol xii.*)

It is the object of this paper to show how to correctly estimate the centrifugal pressure due to any motion, and to check any tendency to the belief that superelevation of outer rails of curves is unnecessary.

Some years back the author made many experiments on centrifugal pressure, with a machine having two arms each about 5ft. in length, and each carrying a sliding weight of about 50lb. These sliding weights were attached by cords passing through the axis of rotation of the machine to a larger weight suspended by the cords.

If $\frac{v^2}{r}$ had equalled (or had been the true basis for the calculation of) centrifugal pressure, a mechanical gain would have resulted on the rotation of the machine, as the weights sliding on the arms would have lifted double the weight which they really did. But $\frac{\text{chord}^2}{\text{dia.}}$ was found to be the prime and true base for all calculations connected with centrifugal pressure (centrifugal pressure is particularised because we never deal with but it alone, and not with pressure and motion combined, or with "force," so-called), and after obtaining a first measure of actual pressure due to any circular motion, we may then use comparative velocities in future calculations, as when using the expression $\frac{v^2}{\text{dia.}}$ in the calculation of proportional pressures.

The expression $\frac{v^2}{r}$ may be properly used only when we are comparing one acceleration, or motion which would be arrived at after an acceleration, with another, as, when a force of 1 will cause an acceleration of 1, a force of 2 will cause an acceleration of 2, and so on, in a unit of time, and in the case when $\frac{v^2}{r}$ gives us twice the deviation from a straight path to a circular motion. It is analogous to the final velocity of an equable acceleration during unit of time—being numerically twice the value of the space passed over in the same time. But there is that in nature which, in cases of perfect circular motion, causes the total outer pressure due to the motion during any time to be equivalent to and to counterbalance the total pull centrewards during the same time. As the total central pull during any time, in the absence of circular motion, would cause motion towards a centre measurable in terms $\frac{\text{chord}^2}{\text{dia.}}$, the total of the outward or centrifugal pressure due to the circular motion, and which is preventive of motion centrewards, is altogether equivalent to that which, acting during the same time, would otherwise cause motion $= \frac{\text{chord}^2}{\text{dia.}}$ centrewards. Or we may take the view that a body would have motion in a straight path, but that an outer pull constrains it to a circular motion. In such case, $\frac{\text{chord}^2}{\text{dia.}}$ = the space through which the outer pull causes deviation from a straight path, and is the result of a constant pull or pressure acting during time: $\frac{\text{chord}^2}{r}$ in the abstract, truly, gives us 2 space (2 ver. sine) during time, or 2 pressures during time; and it is only when we know what we are doing and when treating of force considered as causing an acceleration and final velocity, and then when merely making proportionate measures of such, that we may use terms $\frac{\text{chord}^2}{r}$, or $\frac{v^2}{r}$.

However, not to treat at too great a length on centrifugal force—which is really pressure due to the vis-viva of a body having appetentia to motion in a straight path—the author may state that with a 16ft. arm rotating horizontally about an axis, once in four seconds, any weight at its outer end will have centrifugal pressure sufficient to counterbalance a central pull on it, equal to that which gravity itself would have if free to act on the weight. The weight during one second of time, or a quadrant of the circular motion (and through each quadrant), will counterbalance a pull which otherwise would cause it to have motion through 16ft. in the same time.

This fact, founded upon experiment, will afford a true basis for the calculations of pressures due to circular motions, in all cases, and the truth of it may be tested, astronomically, as

$$\frac{16\text{ft.}}{\text{rad. of earth in ft.}} \times \left(\frac{\text{vel. at equator in ft.}}{25{\cdot}1328}\right)^2$$

should equal the diminishment of weight at the equator because of the rotation of the earth about its axis. And it may also be tested by means of small whirling tables, as $\frac{1}{16}$ rad. × 4 angular velocity should cause a weight at end of a rotating arm, 1ft. long, to counterbalance an equal weight suspended to it through the axis of the machine.

This being the case, the side pressure of any weight passing around any curve at any speed may be readily found, and the superelevation of outer rails may be deduced. In cases of circular motion:—

1. Angular velocity, constant; centrifugal pressure varies as distance.
2. Angular velocity, varying; centrifugal pressure varies as distance inversely.
3. Circular velocity, constant; centrifugal pressure varies as distance inversely.
4. Circular velocity, varying; distance, constant; centrifugal pressure varies as velocity.

Then, taking one of the curves mentioned in "Engineering," we have one of 320ft. radius, which, if passed over at the rate of 32ft. per second, or 22 miles per hour, would cause a side thrust of

$$\frac{1}{20} \times \left(\frac{32}{25{\cdot}1328}\right)^2 = \frac{1\ 62}{20},$$

or about $1\frac{2}{3}$cwt. per ton; and, at 44 miles per hour, the side thrust would (pressure being as velocity squared) equal $6\frac{2}{3}$cwt. per ton. This would be serious with a locomotive weighing 50 tons, and there would not only be a tendency of one-third of 50 tons pressure to displace the outer rails, but the more serious multiplied tendency to strain the axles, in the ratio of the radius of the wheel to the radius of the axle.

An inclination of 1 in 3 would be required to superelevate the rails to suit such curve and such speed; but perhaps we may, in actual practice, take it that a curve of three times the radius, giving but one-third the side pressure and requiring an elevation of 1 in 9 for such speed, may be nearer the mark. However, when we get up to higher speeds, as 60 miles and above, it will be seen that the advantage of longer radius of curvature is quickly discounted, as side pressure and requisite counterbalancing superelevation vary as speed^2.

The great question on a line of mixed traffic is to find a medium which will suit both fast and slow trains. We have seen that slow trains do not need so much consideration as would be implied from the inference specially noted herein, and it may be definitely stated that the very fastest train should rule all the conditions of a line as to radii of curves and superelevations of outer rails; though even for the fastest trains the limit of safety of curves and superelevations affords a fairly-wide working margin.

With regard to the pressures given in the tabulation of the French experiments, there can be very little reliance placed upon them; all means of measuring such are faulty—indeed, nothing is more difficult than to state in terms of pressure, combined pressure and motion, or mass in motion, and still more difficult is it to actually measure the effect, as pressure, of mass in motion.

If experiments were made at certain known speeds up certain known inclines, and the retardation noted—steam being shut off at commencement of ascent of the incline,—and such compared with the retardation due to curves—steam being shut off on entering the curves,—then we might have some approach to correct results; but these results would only tell us that an engine is caused to go slower, if it do not put on a greater quantity of steam when going over a curve (as to atmospheric influences and greasing of rails, they are as nothing)—that is all. We may deduce for ourselves the fact that superelevation is not required to counterbalance the minor effects of centrifugal pressure, and it is with these minor effects alone that the French experiments deal.

Theory would lead to the conclusion that a curve of 320ft. radius would give two minor pressures (at 22 miles per hour) of about 9lb. to 10lb. per ton each, as the main, side, or centrifugal pressure would be 1·62cwt., the mounting or climbing effort of the flanges = 0·162cwt., and the steering effort of the flanges = 0·162cwt., total = 0·324cwt., or about 36lb. per ton; but then the question comes as to how far, if at all, these frictions are eased or overcome by the wheels acting as levers on the axles upon which the effects of at any rate a great portion of them must be ultimately experienced.—G. Pinnington.

Electric Traction.*

The use of electrical energy as a means of locomotion is of recent development, though the idea and the first applications date back to the early days of electrical science, the first attempt to drive a carriage being in 1839. At that time primary batteries were the only available source of a large supply of electric current, and the transforming engines were very crude and inefficient, rendering all serious improvements in electric carriages impossible. On this account it was not until 1873, when the reversible nature of the dynamo was proved, that the possibility of success in electric traction was realised, and in 1879 a small experimental railway was tried in Germany, with such good results that two years later a line was laid in Berlin for practical use, and has continued running up to the present day. The first idea of obtaining power was to collect the current from an insulated conductor laid alongside of the track, the current being generated at some point along the line; but shortly after this time the invention of storage batteries suggested the simpler method of carrying the source of energy about on the vehicle, thus avoiding the necessity of a conductor all along the road, with its obvious inconveniences. The plan was found practicable, and for the last ten years there has been a vigorous discussion, which has not yet been decided, as to which method is the better.

The difference is a fundamental one. By the use of storage batteries the carriage is independent of any specified route, and is complete in itself, so long as the charge is not exhausted. The battery is replenished during idle hours, or is replaced in a few minutes by a relay, and it is applicable to all branches of traction by land or by water. By its means, not only tramcars, but all carriages on all roads can be driven, and it is applicable to the propulsion of small boats or launches. But the objections are in many cases very serious. The storage of any considerable quantity of energy involves the use of a large mass of material, all of which must be carried in the car or boat, largely increasing the dead load; so that, in addition to the cost of the battery, a larger vehicle is required, and more power is used in driving it. It is found, moreover, that the conditions of use on roads are very detrimental to the batteries themselves, the excessive vibration and irregular nature of the work causing the battery to wear out rapidly, with a consequent large expense for renewal. The efficiency of the battery under these conditions is also very low, requiring a large consumption of coal at the generating station. These objections are very marked in carriages and omnibuses, and the use of electricity has not been a success; but in tramcars, and still more in launches, the conditions are more favourable. In fact, the latter have been very successful, since the vibration is reduced to a minimum, and an increase in weight is not of much importance; while the advantages over the only other alternative, a steam or oil engine, are very marked, comprising complete absence of vibration, noise, dirt, and smell. The only objection in this case is the necessity of periodic returns to a charging station for the renewal of the store of energy.

The use of a continuous conductor gives a choice of these arrangements. It may be above ground, on the ground, or below the ground. The first and last are employed mostly for tramcars, the second for railways. In tramway work the third has been used almost exclusively in England, owing to legal restrictions. The conductor is placed in a conduit under the road, and carried on insulators at intervals. At the top is a narrow slot, through which an arm from the car passes down to the conductor. The collector slides or rolls on the conductor, and the current passes up the arm into the car, to the motor, and thence to the rails or back to a return conductor in the conduit—the first being the arrangement of the Holroyd-Smith system, and the second the Love system. To keep out water, mud, and stones, the slot is made very narrow, but still the conduit requires frequent cleaning. Moreover, the very small clearance between the arm and the sides of the slot is a source of trouble, since the slightest hitch involves a great strain on the arm, or wrenches it away from the car altogether. To avoid both these objections, the Brain system has recently been brought out. In this the slot is made fairly broad and the collecting arm strong; over the slot is placed a continuous strip of wrought iron, excluding all mud, etc. Each car is then fitted with a roller at each end close to the ground, and the iron strip

* Abstract of a lecture by Francis G. Baily, delivered to the Liverpool Polytechnic Society

is lifted up and passed over the roller, leaving the slot clean for the passage of the conductor. The iron strip is found to have sufficient flexibility to rise up and run over the rollers and sink back in place when the car has passed. The method promises well, but has not been tried except on an experimental piece of line—Helsby. The conduit system has the advantage of not affecting the road or creating any obstruction, but the first cost of laying it down is very heavy.

The overhead trolley system is largely used in America, and recently has been applied in England. The conductor is carried on poles high above the traffic, like a telegraph wire, and a connection is made by a flexible wire rope from the car attached to a small carriage running along the wire, or by a light rod of steel or wood with a sliding or rolling contact on the under side of the wire. The arm is pressed up by springs at its base, and is fitted with swivel joint to enable it to follow the wire. This arrangement has been very satisfactory; it is inexpensive to erect, the insulation of the wire is easy, and the cost of repairs is small. The objections raised against it are the danger of a heavy wire overhead, which is liable to break, and which is charged with electricity at a fairly high pressure; also the large number of poles required to support the wire are somewhat unsightly, and cause a slight obstruction in the road, but on the whole it is the most promising method for the propulsion of tramcars in streets, and it has recently been employed in America for heavy railway traffic.

The third-rail system, in which the conductor is laid on insulators on the ground, generally between the running rails, is only employed where the track is used for no other traffic. It is coming rapidly into use in place of steam locomotives for local trains in towns, the most prominent examples being the City and South London underground railway, and the Liverpool overhead railway. It has many advantages over the other systems and over other methods of propulsion. The conductor can be well insulated and easily looked after; the collection of the current is safe, and the apparatus simple and strong. There is complete absence of smoke and foul air from the engine, rendering it very suitable for underground work, and there is no danger from sparks and falling cinders—an important point for elevated railways. There is great smoothness of running and absence of jerks in starting, and the short time in which full speed can be attained makes it advantageous for local traffic, where frequent stoppages are required.

The motors which are used in tramcars and trains are of very varied design. With the slow speed in street locomotion, the motor drives the wheels through gearing, the most satisfactory arrangement being a fairly slow-speed motor and a single pair of spur wheels, or else a worm and spur wheel. In the best practice these are carefully cased in and run in an oil-bath, to ensure cleanliness and thorough lubrication. The use of chain gearing is found to be very noisy; and a large reduction of speed by the use of two or more pairs of spur wheels is also both noisy and inefficient. In the above-mentioned railways all gearing is avoided by building the armatures of the motors on the axles of the car or locomotive, thus entirely avoiding the noise and friction of gearing; this, however, necessitates very slow speed motors, and is hardly possible when the speed of the train is less than 12 miles per hour. In underground work, where the space is limited, a separate locomotive is used, while on the overhead railway the motors are placed on the cars in order to distribute the weight over as wide an area as possible.

There are many other examples of electric traction being introduced, such as small locomotives for mines, travelling cranes, and overhead travellers for workshops, which possess great advantages, and will probably have a wide application.

The question of cost is a very important one. Briefly stated, it may be said that for tramcars the accumulator system is the most expensive, and the overhead line is the cheapest, and the latter will compare favourably with any other method of propulsion. But for heavy train work, the efficiency of electric railway from the generating station to the train axle is considerably lower than that of the steam locomotive, so that a general adoption of electricity for general railway work is not likely to take place without some considerable advance in electric methods of propulsion. For the special cases mentioned above, however, which cover a large field for future work, there is every probability of the adoption of electrical in place of steam locomotives, an earnest of which is given by the various lines proposed and under construction in all parts of London.

What Engineering Owes to Chemistry.

When a series of able articles, written by the chemist of the Pennsylvania Railroad, began to appear in a railroad journal several years ago, many persons expressed surprise that a railway company should find it profitable to employ a chemist. When it further appeared that the duties of his position made necessary the employment of an able assistant, the question as to what such men could find to do that would repay their salaries, with profit to the corporation employing them, must have occurred to many. But no one rose from the perusal of those articles with any doubt that the employment of chemical experts was a wise innovation. How the purchases of supplies for this road, amounting to millions of dollars annually, are intelligently guided, how oils, paints, and other articles far too numerous to be recounted, are subjected to a chemical scrutiny that is a certain safeguard against fraud and adulteration; how the sanitary condition of railroad stations and cars is attended to through the administration of the chemical department—was all made clear to the inquiring public.

How could we have contrived to handle, on the great scale in which they now enter into the world's traffic, such substances as sulphuric acid, nitric acid, and other articles in common use, without glass, the only cheap substance that will securely hold these corrosive materials and long resist their chemical action? And but for the supply of these powerful acids, and the long list of compounds made through their reactions, where would have been the engineering arts of mining, metallurgy, and rock blasting? With sulphuric and nitric acids and glycerine, nitro-glycerine has been produced by the chemist, and this has put into the hands of the civil engineer and the military engineer a force to which gunpowder is a mere pigmy.

How many will remember that just three centuries after the discovery of America, Murdoch made the first application of gas to the illumination of cities? For a century previous it had been known that light could be obtained from the gas produced by heating coal in a retort, but Murdoch first demonstrated the value of the discovery. Ten years later the feasibility of such illumination was proved by a public exhibition; and within the succeeding 20 years four gas companies, with 122 miles of pipe, existed in the city of London. It has remained for the last half of the present century to show that the use of gas in engines for the production of motive power is practicable, and for many purposes more economical than the use of steam.

Still less could anyone have foreseen that a by-product of the manufacture of illuminating gas was destined to become an enormous resource in the future of engineering, and that the formerly worthless ammoniacal liquor was to supply the most powerful artificial refrigerating agent ever known to mankind; that the highest engineering skill would be directed to the design of refrigerating machines and apparatus for dealing with it; and that, by its aid, enormous cold warehouses, in which perishable materials could be kept indefinitely, breweries cooled by ammonia, and artificial ice made by its use, would be common and familiar features of the present age.

The refining of petroleum, and the manufacture of lubricating oils therefrom, are not to be overlooked in summing up the debt which engineering owes to chemistry. The animal oils fit for lubrication have been in large measure supplanted by oils extracted from crude mineral oils, which chemists soon discovered to be mixtures of a variety of hydrocarbons that congeal into solids at very different temperatures. The chemical removal of impurities, and the separation and isolation of these hydrocarbons from each other, have given engineers a class of lubricants of previously unknown and highly valuable properties. Most animal oils available for ordinary lubrication become solid at low temperatures, and are therefore extremely difficult to apply in cold weather, such as that to which machinery is subjected in railroading and other outdoor operations. Even if melted by a stove or lamp, they solidify immediately when poured upon a cold metallic surface, or shortly after they have been poured into an oil cup, and their flow to the surfaces needing to be oiled is thus impeded or wholly stopped. From the mineral oils are obtained by separation such as remain liquid at very low temperatures, and are hence now widely used in exposed situations. Combinations or mixtures of such oils, either with other mineral oils, or with animal oils, have enabled the chemist to supply lubricants adapted to all situations and purposes, and the saving in power (formerly wasted) by the use of improved lubricants has been a very great addition to the resources of the modern engineer.

The gain in economy of power formerly wasted in friction, however, has not been wholly achieved by improvements in lubricating oils. The study of alloys, many of which are to be considered as definite chemical compounds, has been fruitful of results in the production of metals in which the normal coefficients of friction are much less than in any metals that could be used for bearings of machinery at any earlier period. In the field of alloys, also, a rich harvest has been reaped by engineers in other ways. Metals resistant to the action of acids and to other corrosive agencies, and metals combining great strength with lightness, have been valuable aids to progress in the mechanic arts. The end is not yet, and the imagination is baffled in the attempt to conjecture what benefits may yet come from the study of alloys. Particularly is electrical engineering indebted to this class of compound metals.

To the resources supplied by chemistry, electrical engineering also owes the materials from which are derived a very large part of the electric power now used. People in speaking of electric power are wont to have in mind principally the generation of the electric current from mechanical power, by dynamos; and this transformation is in itself so wonderful and yet so new, that it overshadows the countless smaller applications of electric power in which the electric current is supplied by chemical reaction in electric batteries. But solely by this means, for a long time the current for operating telegraph instruments was furnished. By electricity derived from batteries millions of diminutive motors are driven to-day, and this original method of obtaining electric power not only continues to be in active demand, but the demand is increasing. Electricity as generated in "storage batteries," "storage cells," "secondary batteries," or "electrical accumulators," as they are variously styled, is regarded by many as likely to assume an even greater importance in the future.

Combustion is purely a chemical process. Its study, primarily by chemists, in developing the conditions under which it can be conducted most economically, has taught engineers how the enormous deposits of carbon in the crust of the earth could be employed profitably to do the bulk of the world's transportation and to supply a large and ever-increasing amount of power to manufacturing plants. When Priestley discovered oxygen in 1774, while delving with rude appliances in the rich but scarcely opened mines of science, he little thought of what immense value the clue he had furnished would prove in guiding the investigators who would succeed him into an understanding of the quantitative character of combustion. It was not until 1807 that the law of multiple proportions in chemical combination was advanced by Dalton; so it may be said that not until the beginning of this century was a true theory of combustion even possible. When it became known that a definite weight of carbon requires for its combustion a definite weight of oxygen, that other constituents of coal likewise demand different but still definite weights of oxygen, to convert them into gaseous products, and that atmospheric air contains, in a given weight, a definite weight of oxygen mixed with a definite weight of nitrogen—the data thus furnished by chemistry for a true theory of economical combustion were seized upon by engineers. They have been used since to formulate principles for the construction of all kinds of furnaces used in human industry, the results being an enormous saving in the industrial use of fuel, as well as the acquisition of the power to generate and maintain high temperatures for metallurgic and other purposes with absolute certainty. Thus the mastery of the engineer over refractory materials has greatly increased.

The art of making bricks and tiles rests upon a purely chemical foundation, and in modern times has been greatly helped by the knowledge of the chemical constituents of clays. In this art, which supplies to engineering one of its most important materials, the means of examining the exact composition of crude materials, as well as manufactured products, has been supplied by chemistry.

Tracing the history of metal working through the ages, I think that we will date the beginning of the "age of steel" from the introduction of the Bessemer process; and it is certain that the Bessemer process never could have come into the world but for the chemical knowledge that preceded it; and when the process was further advanced and improved by the use of what is known as the "basic lining" in the converters, the supremacy of steel as an industrial metal was assured. The profound influence of chemistry, pervading all departments of industry, is not less conspicuous in the improved cements it has placed at the command of engineering science. This age has not only been called the "age of steel," it has also been named the "artificial stone age." The introduction of Portland and other cements, which, when mixed with water, solidify into stone by the chemical action of their ingredients, and are at the same time strongly adherent to surfaces of natural stone, has given birth to a large and increasing industry in the paving of out-door walks and the erection of architectural structures. — A. L. Griswold in "Engineering Magazine."

Trade Notes.

The directors of the St. James and Pall Mall Electric Light Company recommend a dividend at the rate of $9\frac{1}{2}$ per cent. per annum for the half-year ending December 31 last.

Messrs. Wardrobe and Smith, steel manufacturers, have acquired the Arley Steelworks, Arley-street, Sheffield, to which place they will shortly remove their business.

The tender of Messrs. Siemens Brothers and Co., London, has been accepted for the electric lighting of Queen's Quay, Abercorn Basin, and the Hamilton Graving Dock, Belfast.

The West Hartlepool Steel and Iron Company have given an order for a set of ash-washing machinery to Mr. L. A. Edwards, London. 150 tons of ashes per day will be treated.

The directors of Messrs. Samuel Fox and Co. Limited have declared an interim dividend at the rate of 10 per cent. per annum, free of income tax, for the half-year ended December 31 last.

Messrs. Gourlay Brothers and Co., Dundee, are supplying new steel boilers to the steamer "Gordonia," of London, and converting her engines from the compound to the triple-expansion type.

Messrs. Kincaid and Co. Limited, Greenock, have contracted to supply the engines for the 2000 tons deadweight screw steamer to be built by the Campbeltown Shipbuilding Company.

Messrs. John Abbot and Co., Park Works, Gateshead, have just delivered to Sir W. G. Armstrong and Co., Elswick, a phosphor-bronze stern post weighing 13 tons, which is the largest casting of this metal they have produced.

The Sphincter Grip Armoured Hose Company Limited, London, having added to their business a fire and general engineering department, have decided to change the title of their firm to the Sphincter Grip Armoured Hose and Engineering Company Limited.

A movement is on foot for providing Brussels with an underground electric railway somewhat similar to the South London line. It will not have a fixed terminus, but will be arranged like the Inner Circle line, having 11 stations at the most important points of the city.

The directors of the Bristol and South Wales Railway Wagon Company Limited have decided to recommend the payment of a dividend for the half-year ended December 31 last at the rate of 10 per cent. per annum, with a bonus at the rate of 5 per cent. per annum, free of income tax.

Messrs. Perry and Co., London, have secured the contract for the erection of the new baggage and warehouse accommodation for the Inman Line at Southampton, and Messrs. Lucas and Aird will erect the refrigerator and machinery for the dead-meat trade. Both contracts are to be completed by March.

Messrs. Ernest Scott and Mountain Limited, electrical and general engineers, Newcastle-on-Tyne, have been awarded a gold medal for the electric lighting of the Sheffield Trades Exhibition, and also a gold medal for the electric lighting of the Lincoln Trades Exhibition. In both cases the exhibitions were lighted by one of their latest type two-pole Tyne compound-wound dynamos, feeding 10-ampère Tyne arc lamps, the lamps being run in parallel.

Mechanical and Engineering Drawing.—IV.

By a Practical Draughtsman.

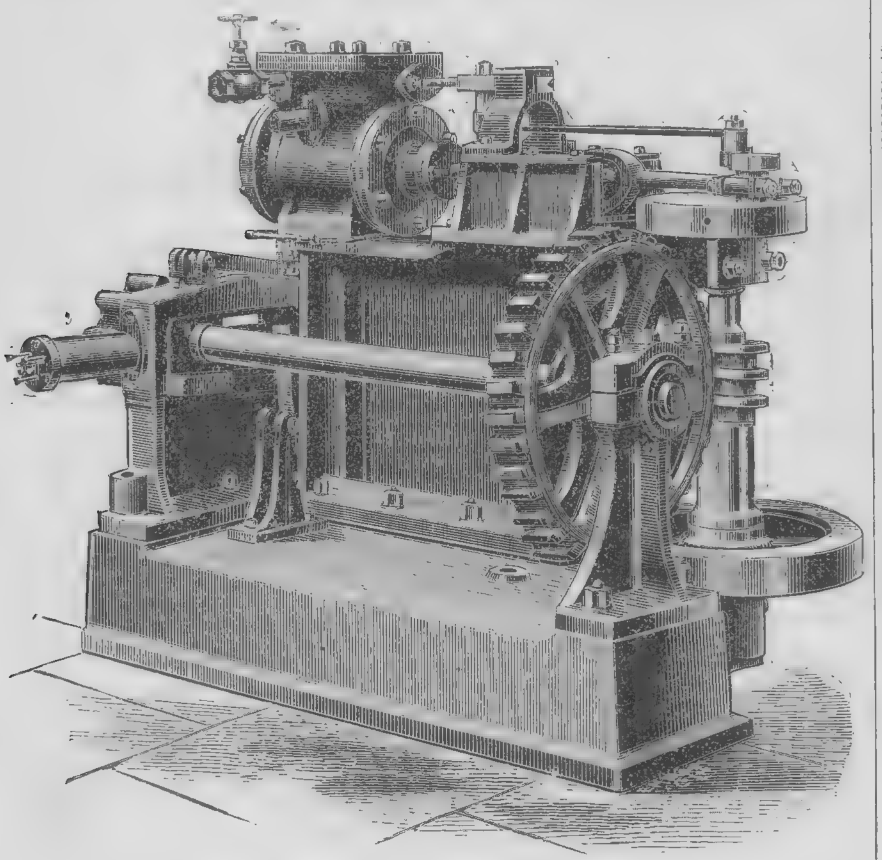
In the study of mechanical drawing in its earlier stages, and even in the making of working drawings for shop use, it is not necessary or essential that the paper on which the drawing is made should be secured to the drawing-board in any other way than by pinning it. This is effected by the use of *drawing pins.* There are, however, several kinds of drawing pins to be had, and their variety is often the cause of difficulty in choosing to the uninitiated user. A pin that would answer well the purpose of the free-hand draughtsman in putting a sheet of paper on his drawing-board, might be the very worst that a mechanical draughtsman could possibly use. The former, not needing a tee-square in the practice of his art, if he does not stretch his paper, pins it down to his board with any drawing pins that are at hand. These may possibly be pins with heads a sixteenth of an inch thick, beautifully milled on their edges and perfectly flat on their under and upper sides. Such pins would be shunned by any mechanical draughtsman who wished to keep the edges of his tee and set squares intact and free from notches. Projecting the whole thickness of their heads from the surface of the paper, they would foul the edges of the tee and set squares and cause damage. The only kind of drawing pin a mechanical draughtsman should use should have a head as thin as possible, without cutting at its edge, slightly concave on the under side or that next to the paper, and only so much convexity on its upper surface as will give it sufficient central thickness to enable the pin to be properly secured to it. There is neither sense nor reason in making the head of a drawing pin half-an-inch in diameter if its circumferential edge does not bear on the paper when its pin is as far into the board as it will go. The purpose of the pin is to keep its head from rising from the surface of the paper, and it need only be long enough and strong enough to effect this. It is better practice to use four small, good-holding drawing pins along the edge of a sheet of paper, than one large, clumsy, badly-made pin at each end of it. Suitable drawing pins which answer every purpose required of them by the draughtsman are now to be obtained for half-a-crown per gross.

As the student from the very commencement of learning to draw should study to acquire the good draughtsman's habits of work, and as one of these is the making of clear, sound lines in his drawing, whether in ink or pencil, it is advisable that he should accustom himself to draw on fairly-good paper. It is not meant by this that such paper as Whatman's is recommended for use in his preliminary work, but rather to guard him against purchasing soft, spongy paper, which will not stand the application of indiarubber for erasing, or of ink for lining in, without damaging its surface or causing the ink to run. Drawing papers are of two kinds—viz., hand-made and machine-made. The former is the best, but is expensive; while the latter is made in great variety, and, as a consequence, of varying quality. Most students, in learning to draw, require a frequent use of the rubber; therefore a tolerably hard-faced paper is desirable. Since the advent of so much drawing as now obtains, a new special make of hard-faced, close-textured cartridge paper has been produced for students' use. It costs about 2d. per imperial sheet, and is very suitable for the purpose. For more advanced work there is, to the writer's knowledge, nothing that will compare with Whatman's smooth double-elephant paper, which takes the finest line either in ink or pencil.

For *cleaning* drawing paper a piece of soft, grey vulcanised rubber should be used, as it will not injure the surface of the paper if properly applied. Its only drawback is the appearance at times in it of small specks of some hard substance like coke dust, which find their way into it during the process of manufacture; these, however, are easily removed when detected. For *erasing* any portion of a line in pencil, a piece of prepared white vulcanised rubber is the best—small rectangular pieces of this material are now to be had of any artists' colourman. What are called pencil erasers, or rubber sticks, are now in common use amongst draughtsmen for the same purpose. They are made in the form of a large square pencil, with rubber inserted in the body of it. To use it the wood is cut away, as is done in pointing an ordinary pencil, exposing the rubber, and it is then applied to the pencilled line with a to-and-fro motion of the hand, pressing lightly, until the line disappears.

A further and all-important requisite to the student draughtsman is ink with which to line in his drawings after they have been carefully put in in pencil. We say this is an "important" requisite, because so much depends on its quality. It is generally known as Indian or China ink. The definition given of it in standard dictionaries —viz., "a substance made of lampblack and animal glue"—is no doubt answerable for the large amount of a material made and sold in Britain under its name. Pure India or China ink is only made in those countries, because the special wood from which it is produced is found only in those regions; therefore in purchasing ink for use on drawings, the only way to ensure its being the real article is to obtain it from a *boná fide* importer. The best mathematical instrument makers are generally importers of it. It is sold in hexagonal sticks, and is expensive, but small oval and round sticks of it are to be had costing about a shilling each.

(*To be continued.*)



Barring Engine. (*For description see page 32.*)

The Glasgow Iron and Steel Company are making extensive alterations at their iron and steel works at Wishaw.

Sugar-making Machinery.

XXVI.

Sugar Mill Foundations.—These have to be deep, and substantial in construction. They are generally constructed of brickwork built in cement, with timber baulks laid top and bottom; the mill bed being laid on the top timbers, and the washer plates placed against the bottom timbers.

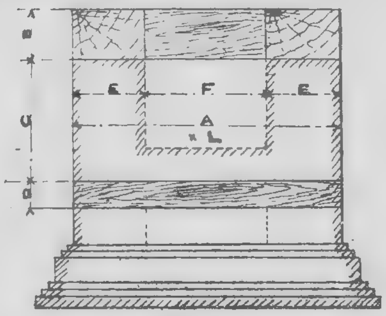


Fig. 63.

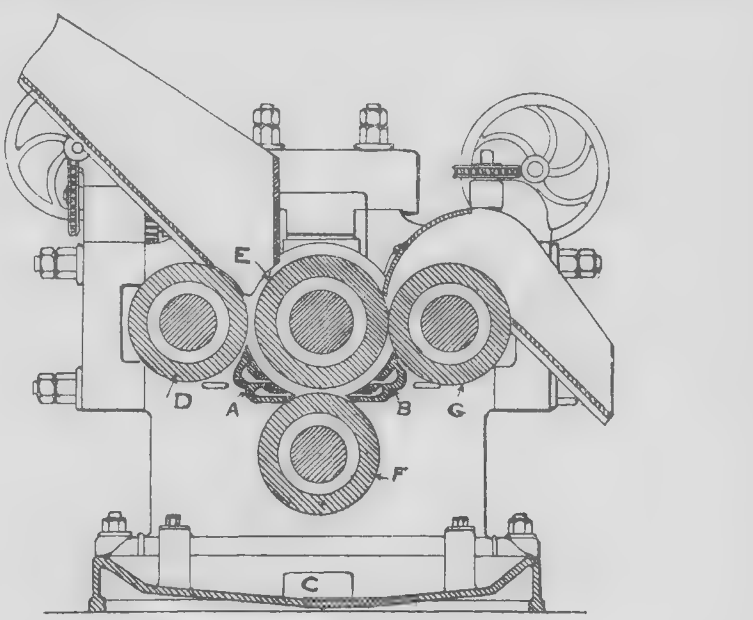
Fig. 63 shows the general form of such foundation, and Table XXIII. gives the leading dimensions for a number of sizes of mills.

TABLE XXIII.

Mill Rolls.	A	B	C	D	E	F	L = Lgth.
in. in.	ft. in.	ft. in.	ft. in.	in.	ft. in.	ft. in.	Abt. ft. in.
18 × 33	5 6	1 0	2 6	6	1 6	2 6	9 0
20 × 36	6 0	,,	3 0	9	,,	3 0	10 0
22 × 42	6 8	,,	4 0	9	,,	3 8	13 0
24 × 48	7 6	,,	4 3	,,	,,	4 6	14 0
28 × 54	8 3	1 3	4 3	,,	,,	5 3	15 0
28 × 60	8 9	,,	5 0	,,	,,	5 9	15 6
32 × 60	10 0	,,	5 0	,,	2 0	6 0	17 0
32 × 66	10 0	,,	5 0	,,	,,	6 0	20 0
34 × 78	11 0	,,	5 6	,,	2 6	6 0	,,

Special Forms of Sugar Mills.—Many attempts have been made to improve on the ordinary three-roller mill as a means of crushing cane, with varying success, and of late years quite a number of special forms of mills have been put upon the market by several of the leading makers of sugar machinery. The improvements have generally taken the form of adding additional crushing rollers to the mill, and varying their disposition so as to more effectually act upon the canes by repeated crushings.

Several of the more important of these special mills we shall here illustrate and describe, pointing out the advantages claimed for them by their respective makers. Nearly all of these mills are provided with four or five rollers variously disposed.



Sugar-making Machinery.—Fig. 64.

Fig. 64 shows a four-roller mill made by Messrs. George Fletcher and Co., of Poplar, London. From the illustration it will be seen that three of the rollers, D, E, G, are arranged in line in the horizontal plane, the centre roll being larger in diameter than the other two. Underneath the larger roll is placed another roll F, the same diameter as the side rolls. Between D and F and between F and G are placed the trash turners A and B. These trash turners are hollow, so that if maceration is desired steam can be turned on and the process commenced in the mill itself. The rollers are set with an opening between the first two rollers of about ⅜in., about ⅛in. between the second and third, and $\frac{1}{16}$in. or less between third and fourth. The arrangement of the rolls, it will be seen, subjects the canes to three distinct crushings. The other parts of the mill are made adjustable in the usual manner.

The top centre roll is driven direct from the second motion shaft of the compound gearing, as with the ordinary mill, the other rolls being driven by spur wheels keyed on each gudgeon in the usual way. The makers state that a mill of this description has been worked on the Alexandra Estate, Cuba, with very satisfactory results. The estate engineer reports that the yield of juice was 78·3 per cent., and of megass 27·7 per cent. The cane experimented with was about fifteen months old, and rather hard, and was estimated to contain 87 per cent. of juice, and 13 per cent. of fibre; so that the yield of juice may be regarded as exceptionally good; being from 15 to 20 per cent. more than would be obtained from ordinary mills. One objection which might be urged against this type of mill is the introduction of an additional trash turner to absorb power in working; the trash turner in the ordinary mill being its most conspicuous defect. Possibly, however, in this mill, owing to the position of the rollers, the usual choking of the mill does not take place.

(*To be continued.*)

The "Umbria" Breakdown.

In view of the unusual interest manifested in the fracture of the "Umbria's" propeller shaft, we give herewith some particulars of the accident, together with sketches (from one of our exchanges) showing the method adopted for the temporary repair.

The "Umbria" is one of the first-class ocean greyhounds belonging to the Cunard Steamship Company, and running between Liverpool and New York. Her dimensions are:—Length, 501ft. 6in.; beam, 57ft. 2in.; depth, 38ft. 2in.; tonnage, 8128; and horse-power, 10,500. Her average speed for all passages is 18·15 knots. On the 23rd of December the fracture was considered to be of so serious a nature as to call for immediate attention, and therefore the engines were stopped, and measures taken to repair the shaft. As will be seen from an inspection of Fig. 1, the shaft failed at a very inconvenient place—between the third and fourth thrust collars. There were two distinct cracks in the shaft, the most serious one running diagonally from flange to flange on one side of the shaft. The first thing done on discovering the failure was to support the shaft by passing a chain cable underneath it, which chain was secured to the steel beams above it. To enable these beams to take the strain they were shored up with timbers. Next, three holes were drilled through the collars of the shaft on each side of the break for the reception of large bolts. This was a work of great difficulty, owing to the limited space, and only five men could advantageously work at once. Shifts of five men each were employed, who worked night and day in six hour watches, operating with hand drills. The metal remaining outside the edge of the holes was chiseled away to permit the insertion of the coupling bolts, which were then dropped in and the nuts screwed up so as to strain the fractured edges of the shaft tightly together. In these operations it is estimated 180in. of iron were drilled through. A clamp or strap was bolted around the shaft between the collar before

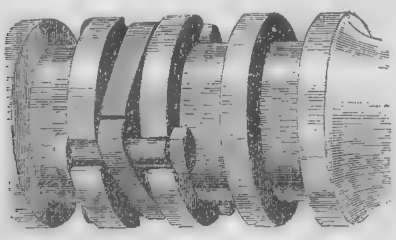
the bolts were put in place. After the bolts were screwed up another strap was put around them, its flanges being turned inward. (See Fig. 2.)

To get at the shaft collars and to permit the rotation of the shaft after repairs were made, several of the thrust block yokes were removed. On the completion of the repairs the engines were slowly started, and the work done proved to be successful, with the exception that, in the course of the first two hours, the head of one of the bolts flew off and a new one had to be inserted, causing several hours' delay. After this all went very smoothly, the ship making about nine miles an hour, and safely reaching New York on the night of December 30. The work of repairing occupied four days' time.

A very fortunate circumstance was the early discovery of the break. Chief-Engineer Tomlinson noticed that the engine was not running properly, and became suspicious; this led to an investigation on his part. Going over the line of shaft and lifting the covers of the first thrust box the fracture was discovered and the engines stopped. The crack had not then penetrated entirely through the shaft, so that the alignment of the shaft was but slightly disturbed.

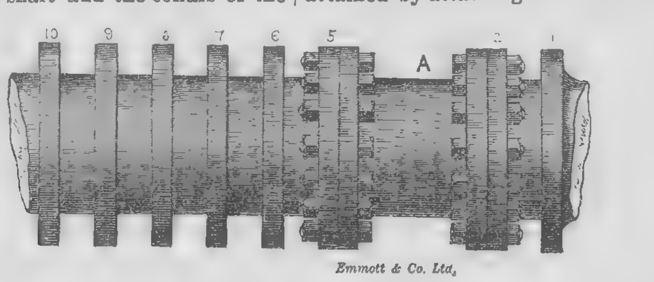
The "Umbria" Breakdown.—Fig. 1.

On the arrival of the ship in New York, the permanent repair of the machinery was considered. To effect this it would be necessary to remove and reheat the present shaft or put in a new one. This would occasion great delay. It was finally decided to make a temporary but more secure repair than that already made, and to bring the vessel back to this country, where a new shaft could be quickly put in and the vessel at the same time be generally overhauled for the expected great passenger traffic of next summer.



The "Umbria" Breakdown.—Fig. 2.

The plan of final repair is as follows (see Fig. 3):—The fractured portion of the main shaft is cut out even with the faces of two of the thrust collars. A short section of steel corresponding in diameter to the shaft, and flanged or collared at both ends, is then set in to fill the space that was occupied by the fractured parts. The collars of the shaft and the collars of the inserted section are then strongly bolted together, as shown in Fig. 3. In this way it is expected a strong and reliable coupling can be made, whereby the ship may safely proceed on her return passage.



The "Umbria" Breakdown.—Fig. 3.

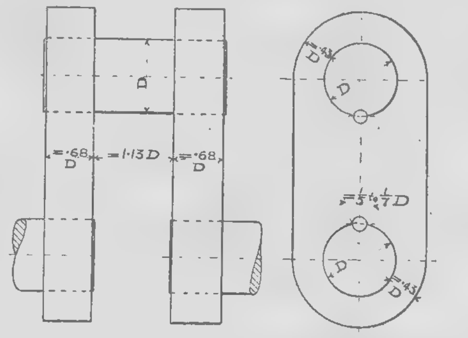
The Birmingham Association of Mechanical Engineers.

The ordinary monthly meeting of the above association was held on Saturday, the 7th inst., at the Grand Hotel, Colmore-row, Birmingham, the president (Mr. A. Driver) in the chair. The ordinary business having been transacted, the balance-sheet was presented by the auditors and duly passed, after which the president delivered the inaugural address, which was very attentively listened to by a large number of members, at the conclusion of which it was resolved, upon the motion of Mr. C. O'Brien, seconded by Mr. G. F. Roberts, that a hearty vote of thanks be awarded to Mr. Driver for his address, and having been duly acknowledged the meeting closed.

The Design and Construction of Stationary Engines.—XLVI.

Fig. 196 shows one form of built-up cranks, the proportional unit for the webs, etc., being the diameter of the shaft.

Balancing Cranks.—This is a very important matter where the speed of rotation is high, say over 100 revolutions for fairly large engines, and 150 revolutions per minute for engines of small and moderate size.



Design, etc., of Stationary Engines.—Fig. 196.

The calculations involved in ascertaining the proper balance weight to be provided for any given engine are too complicated to be of much service in the drawing office.

The parts which require balancing may be divided into two classes—viz. (1) those in which the motion is entirely circular, as in the crankpin and crank; (2) those in which the motion is partly circular and partly reciprocating, as the connecting rod; or wholly reciprocating, as the piston and piston rod. In any part having a simple circular motion, such as the crank, the centrifugal force developed by the motion always acts outwards from the centre; consequently, at one place it tends to lift the unbalanced weight off the bearings, at another it increases the downward pressure upon them, at another place it pulls the bearing to the right, and at another to the left. The direction of the pull is always changing, the effect being to set up vibration varying in intensity with the weights in motion. If it were possible to attach a counterweight on the opposite side of each mass, and in such a position that the centrifugal force developed by its motion will exactly neutralise that developed by the mass, then the parts, such as the crank, would be perfectly balanced. When it is desired to balance parts coming under Class 2 the case is different. The forces produced by a reciprocating or partly reciprocating piece cannot be balanced by attaching a counterweight having a circular motion.

If we consider such a part as the piston rod, when it is moving towards the left, a certain force is developed, and we require something which will produce an opposing force towards the right. This might be attained by attaching a counterweight to the fly-wheel in such a way that when the piston rod was moving to the right, the weight was moving to the left. This would balance the parts in a horizontal direction; but by attaching it to the fly-wheel we cause a centrifugal force to be developed, which acts all round it, is constantly changing in direction, and the piston rod can only balance it in a horizontal direction. The effect on the fly-wheel will be the same as if a weight were continually being put upon it and taken off, once in each revolution, and the result might easily prove a greater trouble than the original difficulty. The same reasoning applies in a less degree to the connecting rod. It will thus be seen that the matter is one for compromise, and all that can be done is to find out in what direction we want the balance to be most perfect.

An approximate value for the balance may be obtained by using the following formula:—

Let W_1 = weight of piston, piston rod, and crosshead in lb.; W_2 = weight of connecting rod; w_1 = a weight which, placed at centre of crank, is equivalent in statical effect to that of the crank webs and crank pin; V = speed of crankpin centre in feet per second; R = radius of crank in feet; L = length of connecting rod in feet; g = 32; C = centrifugal force. Then it can be shown that

$$C = \frac{W \; + W_2}{g}\left\{\frac{V^2}{R} + \frac{V^2}{L}\right\} + \frac{w \;\; V^2}{g\,R} \quad \ldots(1)$$

when crank is at centre next cylinder, and

$$C = \frac{W_1 + W_2}{g}\left\{\frac{V^2}{R} - \frac{V}{L}\right\} + \frac{w_1\,V}{g\,R} \quad \ldots(2$$

when crank is at opposite centre.

While at the two half-centres C will equal approximately

$$\frac{(\tfrac{1}{2}\,W_2 + w_1)\,V^2}{g\,R} \quad \ldots\ldots\ldots\ldots(3)$$

The most that can be done is to consider the value given by (3) as that which should be counteracted by a balance weight—that is to say, consider half the weight of the connecting rod to be concentrated at the centre of crank; find the centre of gravity of the resulting combination of connecting rod, crank webs, and crankpin; then, calling the total weight of these W, and the distance of the centre of gravity from the centre of shaft H—also calling w and h the corresponding quantities in the case of the counterweight—$w \times h$ should be made equal W × H, and w should be placed opposite the crank. The increased amount of centrifugal force near each dead point is partially counteracted by the cushioning due to compression and to lead. One authority states that it is not necessary to balance the crank unless $\frac{V^2}{R}$ is greater than 60 to 80.

The writer has experience of vertical engines running well unbalanced where this value was over 110.

Unwin's rules for balancing are as follow:—For vertical engines, in which the forces at right angles to the line of stroke are most injurious, $W_1 = W_2 \frac{r}{p}$.

For horizontal engines, when the horizontal forces are most injurious,

$$W_1 = \tfrac{2}{3}\,(W_2 + W^3)\,\frac{r}{p} \text{ to } \tfrac{3}{4}\,(W_2 + W_3)\,\frac{r}{p}.$$

Where W_1 = weight of balance weight; p = radius of balance to centre of gravity; W_2 = weight of crankpin and half weight of connecting rod, which may be taken as rotating with the crankpin at radius r; W_3 = the weight of the piston, piston rod, crosshead, and the other half of the weight of the connecting rod.

For horizontal engines in most cases a sufficiently near approximation for the balance weight may be secured by making the counterweight equal to one half the weight of the reciprocating parts, plus the weight of that part of the connecting rod which may be considered as centrifugal in effect.

Suppose the weight of the reciprocating parts of a horizontal engine are as follow:—

	lb.
Piston, rod, and nut	= 750
Crosshead	= 700
Connecting rod entire	= 900
	2350

(Proportion of rod considered as centrifugal, 400lb.)

Then counterweight $= \frac{2350}{2} + 400 = 1575$lb.

Some builders design the counterweight to balance the crank, plus that portion of the connecting rod which is supported by the crankpin when on the dead centres.

(*To be continued.*)

Circulation in Water-tube Boilers.*

A year or more ago Mr. George H. Babcock, of New York, delivered a lecture at Cornell University upon circulation in steam boilers. I was working at the time upon the same subject, and a report of Mr. Babcock's lecture coming into my hands, I was startled by the fact that, though studying and treating the subject in about the same manner and following a similar course, he had reached conclusions differing very materially from mine.

It is not my intention to give here a description of the manner of my investigations, or of how I arrived at the results recorded, as that would necessitate a recital of the many failures incident to a painstaking search for truth. I shall give instead a summary of my efforts in working out a more or less complete theory of water circulation in general, which may be applied to steam boilers of any type. It may be added that so far as I could check my results by observation of the phenomena going on in glass models of steam boilers I have done so; and further, while engaged in my occupation as boiler inspector, many opportunities were presented for the collection of data bearing upon the unseen agitation going on within a heated boiler.

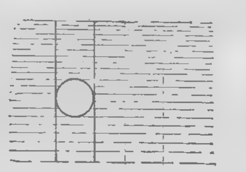
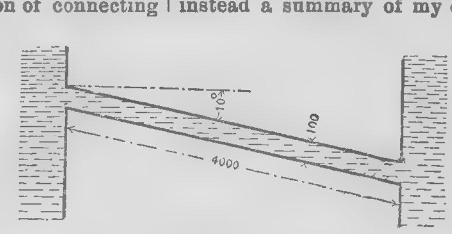


Fig. 1.



Water-tube Boilers.—Fig. 2.

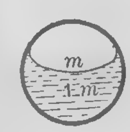
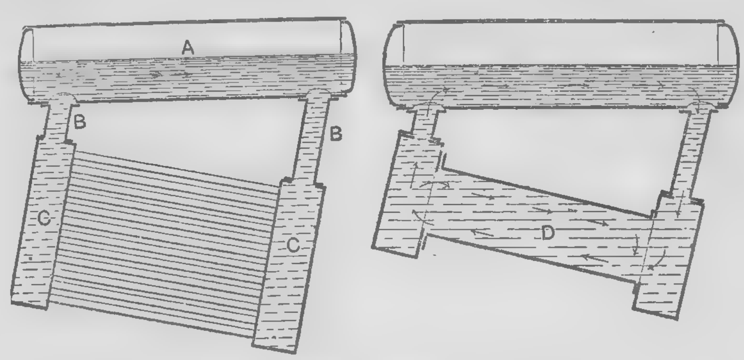


Fig. 3.

The last few years have been very fertile in the production of a variety of boilers consisting essentially of a group of tubes, which are either attached to one another at the ends, or else all attached to rectangular chambers, the whole system being suspended from a horizontal cylindrical drum. I need not point out here the many advantages possessed by sectional and water-tube boilers as compared with boilers of other types, especially for high steam pressures; but I would like to call attention to the fact that there are nearly as many methods of constructing and proportioning water-tube boilers as there are makers of them, each maker claiming for his particular boiler the highest efficiency



Water-tube Boilers.—Fig. 4.

* By Fritz Krauss, in "Power."

resulting from the best circulation. The indifferent observer must needs be compelled to believe that the phenomenon of circulation taking place in a steam boiler is not generally known—that no theory exists as to the laws which govern it. This lack of a theory, so clearly proved by the existence of so many different designs, encourages the writer in this article to set forth his own views on the subject.

Taking it for granted that everybody understands what is meant by the word "circulation," the following questions may be asked and answered :—

1. What are the advantages of a rapid circulation in a steam boiler ?
2. What is the cause of the circulation ?
3. What determines the direction and rapidity of the circulation ?

The advantages arising from a rapid circulation in every part of a boiler are partly mechanical, and they consist partly in an increased efficiency due to the greater facility for the transmission of heat from the fire and gases to the contents of the boiler.

If every part of the steam boiler is traversed by the same rapid and intense stream, it may be supposed that the temperature of the contents is the same in every part. The difference between the temperature of the boiler plates and that of the contents is but slight, even if the extreme outer part of the plates be considered ; practically, therefore, the boiler may be considered as being of the same temperature throughout, this temperature being about that of saturated steam of the pressure carried. It is clear, then, that the injurious stresses arising from unequal expansion and contraction of the boiler are avoided. Furthermore, it is known that those parts of a boiler slowly heated by the exhausted gases before their exit to the chimney are rapidly destroyed by internal corrosion if no precaution be taken to ensure rapid circulation. Internal corrosions may also be found in many feed-water heaters ; in fact, they may always be found wherever a body of water is slowly heated, as the rising air bubbles cling tenaciously to the walls of the vessel. A rapid and thorough circulation, on the contrary, carries these air bubbles to the steam space of the boiler, where they are quite harmless.

External corrosions, also, may result from poor circulation. The plates of the boiler are always about the same temperature as the contents, and are consequently cooler in those parts where the circulation is slow as well as where the cold feed water is introduced ; and the vapours in the fire gases condense at those points, rusting away the outer surface of the plates.

But of extreme importance is the fact, now clearly proved by the investigations of Mr. I. G. Hudson, that the transmission of heat from fire and gases to water is a function of the relative velocity of the heat-furnishing and heat-absorbing mediums.

The second question asks as to the cause of the circulation.

It may be easily shown by a well-known experiment that in heating water in a vessel a circulation ensues. The heated particles of water rise, being pushed by the colder and heavier ones, which always try to lodge at the bottom of the vessel, where they get heated themselves, making place in turn for other now colder ones. As it is impossible to heat a body of water simultaneously and uniformly in every part, there are always hotter and colder or lighter and heavier particles, which cause a circulating movement. But the intensity of the ensuing stream is so very small in relation to the intensity of the movement when the evaporation begins that one might spare the special investigation of this phenomenon. But if we are to consider the phenomena of circulation only to a very limited degree, we may distinguish three phases or stages of phenomena, which present themselves always and everywhere when a body of water is heated up and evaporated.

First stage : Heating without evaporation, causing a very lazy circulation, as described above.

Second stage : Formation of steam bubbles at the plates which are first and directly exposed to the action of the flame and heat, and condensation of the rising steam bubbles in higher and relatively colder strata. The characteristic feature of this stage is that the steam bubbles rising from the fire-sheet become smaller and smaller on their way upwards, and condense before they get to the surface of the water.

Third stage : Continual and regular evaporation. Characteristic feature—the steam bubbles which rise from the fire-sheets become larger and larger on their way upwards, and break the surface, bursting to the steam or air space. Highest intensity of circulation. This is the circulation we are investigating, and this circulation may be described as being directly caused by the evaporation.

We now reach the third question, asking for the determination of the directions and intensity of the circulating stream. This question cannot be answered in general, the direction and intensity of circulation being different in different types of boilers. To secure information on this point it is necessary first to determine the velocity and acceleration with which a steam bubble of certain size, suspended in water, tries to get to the surface. If a force P gives to a body of the mass m an acceleration f, the following relation is established : $P = m f$. According to Archimedes' law, $P = W - S$, if S designates the absolute weight of the steam bubble and W the absolute weight of a body of water the same size as the steam bubble. If g is the acceleration of gravity, then

$$m = \frac{S}{g}.$$

Therefore, $$W - S = \frac{S}{g} f,$$

or $$f = g\left(\frac{W}{S} - 1\right).$$

At a pressure of say about 142lb. per sq. in. absolute

$$\frac{W}{S} = 201, \text{ and } f = 200\, g.$$

If the surface of the water is h feet above the steam bubble, the velocity of the bubble at the moment of striking the surface will be

$$v = \sqrt{2 \cdot 200\, g\, h} \text{ feet,}$$

friction and other resistances in pushing aside the surrounding body of water being neglected. But it is a condition that the surrounding body of water may be pushed aside. If this is not the case, and a tube be put over the steam bubble, as shown in Fig. 1, it is seen that the bubble when rising must raise the column of water above it as well as that beneath it. The potential energy necessary may be supposed to be furnished by another and neighbouring column of water, as shown by the dotted lines. If the tube with the bubble is closed at the lower end, no movement can take place, the potential energy having no opportunity to change into kinetic energy. If the bottom of the tube is only partly closed the movement of the column will be much slower than when the whole area is open. The velocity of the water entering at the bottom is determined by the formula

$$v = \sqrt{2 g m h}$$

if h is the length of the tube and m the proportion of the volume of the bubble to that of the whole tube. The absolute weight of the bubble in respect to the mass of water, being but a trifle, has been neglected, as well as the resistance by friction.

If the tube is completely filled with steam, then $m = 1$, and

$$v = \sqrt{2 g h}.$$

If the area of the tube is partly closed at the bottom, the calculated velocity is that in the remaining area.

These few remarks enable us to get some information about the movement of water and steam in narrow and slightly inclined tubes.

Let us consider a straight tube 13ft. long by 4in. wide, with an inclination of 10°. The dimensions of this tube are about the same as those generally made use of in water-tube boilers. The ends of the tube are expanded into two large water chambers or water legs. This tube exposed to fire heat has a total heating surface of 13sq. ft. Assuming a rate of transmission of 5 units per hour per sq. ft. of heating surface and degree difference of temperature, with a temperature of 2200° F. of the fire and 350° of the steam, corresponding to about 142lb. absolute pressure per sq. in., about 100lb. of water per hour would be converted into steam in the tube, if its whole length were exposed to the fire. The grate usually being not longer than 6ft., half the quantity may be considered near the truth, say 50lb. of steam generated per hour. The total volume of the steam generated would be 161 cubic ft. per hour, or 0·045 cubic ft. per second, say 77·8 cubic in. The head of water for the propulsion of the steam bubbles at the mentioned inclination of 10° is 6 sin 10° = 1·044ft., and the velocity attained at the end of the tube

$$v = \sqrt{2 \cdot 200 g\ 1 \cdot 044} = 116\text{ft.},$$

the mean velocity in the tube being 58ft. per second. If now the steam fills only the xth part of the tube, the area of the steam flow through the tube can be determined as follows :—

$$\underset{\text{(volume per sec.)}}{77 \cdot 8} = \underset{\text{(area)}}{12\ 566 x} \times \underset{\text{(velocity per sec.)}}{12 \times 58}$$

$$x = \frac{1}{112}.$$

The area of the steam space in the tube is only the 112th part of the area of the tube, or $\frac{12 \cdot 566}{112} = 0 \cdot 112$sq. in. This is calculated with the assumption that the water in the tube is quite stationary, without any motion whatever, which is not in accordance with practice. If the water is to be accelerated by the steam flowing through the tube, then the steam must lose part of its own velocity. Now if the same quantity of steam per hour is to be generated, the area of the steam space must necessarily be larger—that is to say, the steam bubbles must be a good deal more voluminous. To determine the velocity of the stream the formula $v = \sqrt{2 g m h}$ must be applied, in which m measures the proportion of the steam space to the total area of the tube. If we are to determine the maximum velocity the stream may possibly attain, the following method may be taken. The total area of the tube, which is partly filled with steam, and partly with water, is equal to unity. Then the area of the water space being m, the area of the steam space becomes $1 - m$. The attainable velocity is $v = \sqrt{2 g m h}$, and the quantity of water flowing through the tube per second is

$$(1 - m)\, v = (1 - m) \sqrt{2 g m h}, \text{ or}$$

$$\sqrt{2 g h}\, (\sqrt{m} - m \sqrt{m}).$$

The first differential quotient equal to zero gives the condition for the maximum quantity,

$$\tfrac{1}{2} m^{-\frac{1}{2}} - \tfrac{3}{2} m^{\frac{1}{2}} = 0, \text{ or } \overset{\text{L. P.}}{\sqrt{m} = 3 \sqrt{m}}, \text{ or } m = \tfrac{1}{3}.$$

If, therefore, the steam space is exactly one-third of the total area of the tube, then the rate of circulation is highest. In our case the steam space would be $\frac{12 \cdot 566}{3} = 4 \cdot 188$ sq. in., and the velocity $v = \frac{77 \cdot 8}{4 \cdot 188} = 18 \cdot 6$ft., or 1·55ft. per second. The head of water necessary for this velocity is

$$h = 3\, \frac{1 \cdot 55 \times 1 \cdot 55}{2 g} = 0 \cdot 1126\text{ft.}$$

An inclination of two degrees of the tubes would suffice to give the necessary head. But taking into consideration the many resistances of friction, etc., the greater inclination generally adopted may be justified. The calculations given above are of course only true if the area of the chambers or water legs by which the water streams to the tubes have in every section also an area of at least two-thirds of the total tube area. If this is not the case, the water legs being of small proportionate area, then matters are quite different. Then the legs must be considered as similar to the single tube previously considered, and it may be easily understood that the maximum velocity of the water flowing through the legs is attained if one-third of the rising leg is filled with steam. The formation of steam necessarily takes place for the greater part in the tubes at the bottom, which are directly exposed to the action of the fire.

In the bottom tubes, therefore, the circulation is more rapid than in the higher ones, and the head of water is also greatest. The circulating stream takes its way, therefore, through the bottom tubes, and the higher ones have no opportunity of joining in the stream. Furthermore, if the area of the connections between the water legs and the upper drum is so small that it corresponds to only two or three rows of tubes, then it is clear that only in these two or three bottom rows the desired direction of the circulating stream can be maintained. In the upper rows of the tubes the direction of the circulating body of water is quite reversed, while the few steam bubbles which rise in them whirl about and find their way with difficulty to the rising leg.

For further support of these views, which of course are not in accordance with most of the theories set forth in pamphlets and circulars of water-tube boiler factories, I shall advance some further arguments. If in Fig. 4 A is the upper steam drum, with which by very narrow connections BB two waterlegs CC communicate, which are themselves united by a great number of tubes, the latter being exposed to the direct action of a fire underneath, then it may be called a hard test to one's senses to have to believe that the same intense and equally directed stream traverses every tube.

(To be continued.)

During the year 1892 175,000 tons of iron ore have been despatched from the Gellivara iron ore mines to the port of Lulea for shipment.

Metal Trade Memoranda.

It is stated that the Romay Iron Mining Company have begun the smelting of iron at its works in the province of Catamarca, in the Argentines. It enjoys a guarantee from the National Government on its capital. A committee of shareholders visited the mine some months ago, and reported most favourably on the abundance and quality of the mineral.

The large demand for iron has recently induced the proprietors of the Dombrowa-Gornieza Works, Russia, to considerably enlarge and improve their plant, whilst at those in Sielce, near Sosnowice, Martin furnaces have been built and set in operation. In addition to these, two new wire and iron sheet rolling mills have just been started at the works in Huta-Bankowa.

Messrs. E. Morewood and Co., South Wales Works, Llanelly, who erected new tinning works at Elizabeth Port, New Jersey, a short time ago, have acquired the Burry Tinplate Works, Llanelly, until lately in the occupation of the Burry Tinworks Company. The works will probably be utilised for the manufacture of black plates, which will be forwarded to the American establishment to undergo the tinning process.

Official Gazette.

Partnerships Dissolved.

M. H. Barnard and E. J. M. Clapham, under the style of R. F. Dale and Co., Westminster Bridge-road, S.E., and Burdett-street, S.E., engineers and brassfounders.

J. Higginbottom, T. Mannock, and J. C. Etchells, under the style of Higginbottom and Mannock, Gorton, near Manchester, engineers and millwrights ; as far as regards J. C. Etchells.

W. Todhunter and J. G. Elliot, under the style of Todhunter and Elliot, Douglas, Isle of Man, ironmongers, iron merchants, iron and copper smiths, plumbers, and gasfitters.

E. F. Parks and R. G. Cullerne, under the style of Parks and Cullerne, Croydon, engineers.

J. W. Fitter, J. E. Tay, and D. H. Gill, under the style of the Standard Tube Company, Aston, tube manufacturers ; as far as regards D. H. Gill.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Adjudication.

Charles Bullard, Ipswich, agricultura engineer and blacksmith and innkeeper.

New Companies.

North's Typewriting Manufacturing Company Limited.—This company was registered on the 12th inst., with a capital of £24,000, in £5 shares, to adopt a specified agreement, and to acquire the goodwill of a typewriting machine manufacturer, or any other similar business, and to carry on the trade of ironfounders, ironmongers, manufacturing engineers, mechanicians, manufacturers, and dealers in typewriting machines and other mechanical contrivances. The number of directors is not to be less than 3, nor more than 5, J. T. North being the first ; qualification, 200 shares ; remuneration to be fixed by the company in general meeting. Registered by H. J. Clabburn, 63, Lincoln's Inn Fields, W.C.

Harvey Steel Company of Great Britain Limited.—This company was registered on the 14th inst., with a capital of £180,000, in £10 shares, to carry on business as manufacturers of armour-plates and plates of all kinds, whether of steel, iron, bronze, metal, aluminium, or any other metals or combinations of metals, with or without additional alloys or substances, and to carry on the business of steel and ironfounders and masters, brassfounders, tinplate makers, etc. Until otherwise determined by a general meeting, the number of directors is not to be less than 2, nor more than 7 ; qualification, £500 ; remuneration to be fixed by the company in general meeting. Registered by Fladygates and Co., 2, Craig's Court, S.W.

Weldless Chain Company Limited.—This company was registered on the 12th inst., with a capital of £100,000, in £10 shares, to apply for, purchase, or otherwise acquire any patents, brevets d'invention, concessions, and the like, or any secret or other information as to any inventions relating to the manufacture, improvement, or treatment of chains, cables, etc., weldless or otherwise, or the links, loops, bars, snap or other hooks, or other component parts or attachments, or any plant or machine in connection with any of these articles. The number of directors, until otherwise determined by general meeting, is not to be less than 5, nor more than 9 ; qualification, £500 ; remuneration, £100 each per annum, together with certain percentage. Registered office, 2, Victoria Mansions, S.W.

Patent Syndicate Lighting Oil Extractor Company Limited.—This company was registered on the 14th inst., with a capital of £15,000, in £10 shares, to purchase or otherwise acquire patents, etc., or other information as to any invention which may seem capable of being used in the extraction or manufacture of oil from oleaginous subjects and waste products, and in the manufacture of resinous substances, essential oils, and balsams, and in the extraction and manufacture of chemicals, sulphur and other results from ores and other substances, and to carry on the trade of ironfounders, mechanical engineers, metallurgists, electrical engineers, gasmakers, and other businesses in connection with such as these. There are not to be less than 3, nor more than 7 directors ; qualification, £200 ; their remuneration is to be fixed by the company in general meeting. Registered by Jordon and Sons, 120, Chancery-lane, W.C. Registered office, 27 Kirkgate, Bradford, Yorks.

The Metal Market.

PRICES CURRENT.

LONDON, Jan. 23.

COPPER opened firm, with holders asking 2s. 6d. more, which was afterwards paid, three months selling at £46 7s. 6d., and £45 16s. 3d. was taken for three months, sellers' option. Buyers operated cautiously, but the lightness of offerings lent support to the market, and £45 17s. 6d. was paid for a few days prompt, and later for sharp cash. Three months was also done at £46 6s. 3d., at which there were buyers in the afternoon; but sellers remained firm, and values closed at the opening advance in an inactive market. Sales, 250 tons. Settlement price, £45 17s. 6d. English tough, £49 to £49 5s.; best selected, £50 10s.; strong sheets, £59.

TIN began with an uncertain feeling; but three months, after being offered at £93 12s. 6d. to £93 10., lost 5s., business being concluded at £93 7s. 6d., cash following at £93 2s. 6d., at which, however, little was offered, and £93 5s. was afterwards made. The tone was quiet, buyers to some extent holding off, and ultimately, after Australian (Pyrmont) cash had realised £93 15s. three months, Straits declined to £93 5s., and final values are steady at 5s. to 7s. 6d. below previous closing rates. Sales, 70 tons. Settlement price, £93 2s. 6d. English ingots, £96 to £98 10s.

PIG IRON has been inactive, business being hindered by the high prices asked. The market opened with cash sellers at 43s. 10d. and buyers at 43s. 8d., but in the afternoon the price advanced to 44s. for the week's prompt, the best bid being 43s. 10½d. Closing rates are 2d. better for Scotch, but 3d. worse for Middlesbrough, and 1½d. for hematite. Settlement prices: — Scotch, 43s. 11d.; Middlesbrough, 35s. 3d.; hematite, 45s. 10d.

TINPLATES are absolutely inactive, except for wasters, for which there is a good demand at 3d. below the price of perfect lots.

LEAD has been firm, and closes 1s. 3d. better at £9 16s. 3d. to £9 17s. 6d. English, £10.

SPELTER is quiet, but ordinary is not offered under £18 2s. 6d. Silesian specials, £18 17s. 6d.

ZINC SHEETS.—Silesian are quiet at £20 15s. ex ship. Belgian steady, the V.M. brand ex ship being £20 17s. 6d. and f.o.b. Antwerp, £20 15s.

OFFICIAL CLOSING QUOTATIONS.

	To-day.	
	£ s. d.	£ s. d.
COPPER—		
G. M. B.—Cash	45 17 6	—46 5 0
„ Three months	46 6 3	—46 13 9
English tough	—	—
Best selected	—	—
Strong sheets	—	—
TIN—		
Fine foreign—Cash	93 2 6	—93 12 6
„ „ Three months	93 5 0	—93 15 0
Australian—Cash	93 15 0	—94 5 0
PIG IRON—		s. d.
Scotch warrants—Cash		43 11
„ One month		44 0
Middlesbrough—Cash		35 3
„ One month		—
Hematite—Cash		45 10½
„ One month		—

GLASGOW, Jan. 23.—The pig iron market was very idle, and only a few thousand tons of Scotch changed hands. A local oversold account was closed at the forenoon market, and that kept the cash price firm at 43s. 9d., but three months forward was offered at 42s. 6d. without finding buyers, though six weeks forward commanded for a small lot 42s. 3d. Cleveland was offered at 35s. 5½d. with no takers. The shipments of Scotch for the week were 3065 tons, a decrease on the corresponding week of 828 tons, making for the year a decrease of 1904.

QUOTATIONS.

	Highest. s. d.	Lowest. s. d.
Scotch warrants—Cash	43 11	43 8½
„ One month	44 0	43 9
Middlesbrough—Cash	35 4½	35 3
„ One month	—	—
Hematite—Cash	45 10½	45 10½
„ One month	—	—

Letters to the Editor.

**** We do not hold ourselves responsible for opinions expressed by correspondents.*

**** The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

**** Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

TRANSVERSE STRAINS.

To the Editor of THE MECHANICAL WORLD.

SIR,—In calculating the strength of beams, etc., I have sometimes been at a loss to know what stress to allow for transverse strains. It may also interest other of your readers. For instance, in Molesworth's Pocket Book, pages 16 and 18, under the heading "Strength of Materials," the transverse strength of metals is given so low, compared with other authorities, that I think there must be some difference in the experiments or the naming of the terms. In Rankin's "Rules and Tables," page 199, the resistance to breaking across (which I take to mean the same as transverse strength) is given for cast iron as 17,000lb. per sq. in., whereas Molesworth gives it as 2·6 tons (5800lb.); and other materials are just in the same proportion. D. K. Clark gives the transverse stress as about 7 tons for cast iron.

I take the transverse strength to be the strength of a beam supported at one or both ends, and the load distributed or concentrated, as the case may be; and I have seen experiments tried. Working out the transverse stress from the formula :—

$$\text{Bending moment} = \frac{BD^2}{6} \times f,$$

f (the stress) came out to be (in the case of a rectangular white pine beam) about 8000lb. per sq. in., whereas Molesworth gives it as 1229lb. Again, in the well-known practical test: A bar of cast iron 1in. square and 1ft. long is found to break with a load of 1 ton applied at the centre. Working this out from the same formula :—

$$f \times \frac{BD^2}{6} = \frac{WL}{4},$$

the stress f comes out to be 40,000lb. As these results differ so much from those given in Molesworth, I should feel much obliged if some reader would point out wherein the difference lies, or if the terms are misapplied. I don't think the numbers given can be the working stresses, as the other columns (the tensile and crushing stresses) are the breaking stresses.

MECHANICAL DRAUGHTSMAN.

Belfast, Jan. 21.

THE MANUFACTURE OF COAL GAS.

To the Editor of THE MECHANICAL WORLD.

SIR,—In reference to the paragraph in your issue of the 20th inst., referring to the production of coal gas and to the waste of tar and ammonia in the present methods of coking and using coal, will you permit me to say that £1,000,000 a year is not within measurable distance of the total?

Every particle of coal used for manufacturing and household purposes ought to be turned into gas, the by-products collected, and then the gas used instead of crude coal.

The tar and ammonia would probably yield not one, but ten millions a year. The gas would do twice as much work as the coal now does, and our towns would be free from smoke.

The gas could probably be supplied, including 10 per cent. on the outlay, for 6d. per 1000ft., and the economy all round would be enormous.

There is no difficulty about it; it does not require any "ingenious person to show how," but only needs a little money and pluck to start it.

Any county council would exercise a wise economy in spending £500 to test it.

T. NICHOLSON.

Colwyn Bay, Jan. 23.

Miscellaneous Items.

A discovery of anthracite coal, promising to be of some importance, has been made in a bog at Hede, in the south-west of Sweden. The quality is said to be good, and the samples burn freely. The coals are now being analysed at a public institute in Gothenburg. Hitherto no coal has been found in this part of Sweden.

An immense fir pole has lately been erected in front of the Washington State building at the Chicago Exhibition. It came from a forest near Mount Everet, where it towered to a height of 300ft. When the top was cut off there was a trunk of 238ft. left. Owing to its great length, the tree had to be cut in two, so as to enable it to pass over the lines of the railway, the curves being unsuited to its being carried whole. Even when cut in two four cars were required for each piece. When it reached Jackson Park it was spliced with a steel band, and after considerable labour and expense it was got on end with a globe on the top, and it now forms a most conspicuous object in the grounds.

Starting from the most general and obvious means of conveying power from motor to machine—the common leather belt,—Sir R. Ball remarks that a light, fast-running cotton rope may be substituted for the heavy, slow-running belt, when the conditions are favourable to the exchange of speed for weight. Following up the line of reasoning thus presented, Sir R. Ball shows that a rope as light as sewing cotton, running at the speed of a rifle bullet, would carry a horse-power. Proceeding to the extreme case of the lightest kind of line known (that of a spider's web) and the highest known velocity of travel (that of light), Sir R. Ball arrives at the astounding conclusion that if a line of spider's web could be driven with the speed of light, it would carry something like 250H.P.

The Manchester and Salford Noxious Vapours Abatement Association have presented a memorial to the Gas Committee of the Corporation of Manchester, urging upon them the advisability of a reduction in the price of gas when used for purposes other than illumination. Various reasons are put forward in support of the reduction. Gas cannot compete successfully with coal at a cost greater than 2s. per 1000 cubic feet, when used for the purposes of heating, cooking, and power. An increased use of gas instead of coal would effect a great improvement in the condition of the air of Manchester. It is also urged that it is unjust to large consumers of gas to compel them to contribute to the rates more than their proper share in proportion to the gas they consume. Messrs. Crossley Bros. Limited, Openshaw, specially recommended that users of gas engines should band themselves together with the idea of getting a special reduction for motive-power purposes. As a test of the usefulness of a reduction of 6d. per 1000 cubic feet, it is suggested that it might be tried for a period of about three years.

In a paper by Prof. Kernot, read before the Victorian Institute, he compared the various estimates as to the weight per square foot of a crowd. One estimate, quoted as French practice by Stoney and Trautwine, gives 41lb. per square foot as the weight of a crowd. Hatfield, in "Transverse Strains," gives 70lb.; Mr. Page, engineer to Chelsea Bridge, 84lb.; Mr. Nash, architect to Buckingham Palace, quoted by Tredgold, 120lb.; Mr. W. N. Kernot, at Working-men's College, Melbourne, gives the weight as 126lb.; Prof. W. C. Kernot, at Melbourne University, puts it at 143·1lb.; and Mr. Bindon B. Stoney, in his work on "Stresses," at 147·4lb. per square foot. The space occupied by soldiers, as taken by Hatfield in his estimate, is not the same as a crowd. Soldiers are arranged in lines at a distance apart to allow room for knapsacks and other accoutrements; but a crowd is forced together into close contact, an average man in a crowd occupying a space of little, if any, more than 1sq. ft. On the whole, Prof. Kernot inclines to favour Mr. Stoney's estimate of a little more than one man per square foot, and gives it as proved that a dense crowd of well-grown men weighs between 140lb. and 150lb. to the square foot.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

POOLE'S GRINDING MACHINE FOR LATHES.—Required, the address of makers of this machine.

FILTRATION.—Will any reader state the best method of filtering 150 gallons of canal water per day for steam-boiler purposes?—T. H. MITCHELL.

SQUARE SHAFTS FOR CRANES.—I shall be glad if any reader can give me the names of any firms who make a specialty of large square shafts for cranes.—INQUIRER.

TWIST DRILL CUTTERS.—Can any reader give me a method of getting the correct thickness and shape of cutter for any diameter of twist drill, straight lip? A drawing will greatly oblige.—J. M. F.

"GRASS" PACKING.—Can any reader supply me with the address of manufacturers of this packing? I have seen it used for the piston and valve rods of L. and N.-W. railway engines.—LOCO.

ENGINEERS WAGES.—Would any reader kindly give me some information as to the wages at Cape Colony and Mexico for mechanical engineers?—REGULAR READER OF "THE MECHANICAL WORLD."

HEATING FURNACE.—Will any reader kindly give particulars, with rough sketch, of furnace suitable for heating and fagotting iron up to 3in. diameter and about 2ft. long for 2cwt. steam hammer?—HAMMER.

HEATING STEEL.—Would any reader kindly explain the following?—If one takes a piece of steel, heats it to redness in a fire, then chalks it over and dips it into cold water, it is as soft as iron when it comes out.—GOOD TEMPER.

BLOWERS V. FANS.—Will any reader supply me with some reliable data for calculating the power required to drive blowers and fans? I would also be glad of an opinion with regard to their comparative merits in blowing blacksmiths' fires.—POWER.

LOSSES IN STEEL FURNACES. — Could any reader kindly inform me the average per cent. of actual loss, and the average per cent. of skull, in the charge of a Siemens open-hearth steel furnace working charge of from 30 to 40 tons? And also the percentage of loss in heating slabs and ingots in the Siemens regenerative gas furnace?—J. R. R.

STRESSES IN BEAMS.—(1.) What is the shearing force and bending moment at the fixed end of a bracket whose length is 14ft., and which carries one ton at the free end and two tons at 4ft. from that end? (2.) A beam of 20ft. span, supported at both ends, carries a weight of 6 tons at 5ft. from one support, and another of 7 tons at 8ft from the same support. Calculate the reactions at each support, and the bending moments at each load.—R. B.

COAL MINING. — Will some reader of THE MECHANICAL WORLD kindly say how many tubs should be run each journey to work an incline of 1 in 14 and 1100ft. long, so arranged that the full tubs going down will bring up the empty ones? Weight of tubs, full, 15cwt.; empty, 5cwt. each; would two tubs each journey be sufficient? Which would be the best to lower the tubs with—a brake drum or a horizontal brake pulley? Please say how to calculate the weights for working inclines of various gradients when arranged as the above.—AUTOMATIC.

WINDING ENGINE.—What weight would a pair of 36in. cylinder engines by 4½ft. stroke raise from a pit with a spiral drum, commencing at 14ft. and finishing at 18ft. diameter, one side to wind from a depth of 350yds. and the other side from 400yds.; ropes to be 1½in. diameter, boiler pressure 30lb. per square inch, cut-off at ¾ stroke? What weight would the above engines raise from a depth of 280yds., with a flat rope drum, commencing at 12ft. diameter; sizes of ropes 5½in. by ⅝in. (steel)? What would be the rise in inches per yard of a slant whose angle is 26 degrees?—MINER.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

W. H. COOPS.—We can supply you with a copy of the work. Price 5s.

TOOLS.—You will find a table of tangents in Molesworth's Pocket Book.

INFORMATION.—Heat it by means of a gas flame, and apply petroleum to the joint.

B. C. J.—Hasluck's "Screw Threads" (1s. 6d. will suit you. It may be had from our office.

ANXIOUS.—Messrs. Charles Churchill and Co., Ltd., 21, Cross-street, Finsbury, London.

D. W.—M. Colyer's "Pumps and Pumping Machinery," 12s. 6d., is the only work we know likely to suit you.

H. A. S.—Graham's "Brass Founding," 2s., contains some few particulars, but we know of no book likely to be of much service to you.

ONE IN A FIX.—(1.) There is probably some means provided for increasing the tension of the springs, and if so, you can readily modify the speed. (2) Yes; your idea is quite correct. Get a copy of "First Principles of Mechanical Engineering" (3s. 6d.), from our office.

A NEW READER.—We would advise you to procure a syllabus of the course of instruction advocated by the Royal School of Mines, Jermyn-street, London, and follow up the plan given as nearly as you can by attending classes in mining, mineralogy, geology, chemistry, etc.

FORGINGS.—(1.) The sand fuses and combines with the impurities. (2.) Greenwood's "Iron and Steel," 5s.; may be had from our office. (3.) Multiply the area of the piston by twice the length of the stroke in feet, and by the number of revolutions per minute. The product divided by 33,000 gives the indicated horse-power.

CORROSION IN GAS ENGINE JACKET.—We have a gas engine, and find, when we draw water out of cylinder jacket, that it is quite muddy with corroded iron. Can anyone inform us how to stop this corrosion?—W. W. AND SONS.—*A.*—If you keep the jacket quite full of water, and circulating as it should, the corrosion will not be serious unless the water is acid. Corrosion takes place chiefly at the high-water mark, or owing to the surfaces being alternately wet and dry. One of the water-circulating pipes should lead from the extreme top of the jacket, so that no air or steam from the water can accumulate in the space and so leave a line "between wind and water."—T. J. B.

FRENCH AND ENGLISH WEIGHTS. — Can any reader inform me of a work converting tables of weight per millimetre into English pounds per metre run?—ANGLO-METRIC.—*A.*—It is very improbable that precisely such a table as you desire is published. Possibly, "Metric Measures and their English Equivalents" (price 3s.), by G. M. Borns, might be of some use to you. It is published at 55, Bedford-street, Strand, W.C. But as 1 kilogramme is equal to 2·20461lb., and as there are 1000 millimetres in 1 metre, it is only necessary to multiply any weight expressed in kilos. per millimetre by 2204·61 to ascertain its weight in lb. per metre run.—T. J. B.

GRINDING VALVES.—Will any reader advise me as to the best means of scouring brass valves and seats to a smooth face? I have tried flour emery, and a fast speed. but as I get at times different mixtures of metal in the valve and seat, I cannot smooth them both together.—W. THOMAS.—*A.*—The red, well-burnt sand from the core of a brass casting, well sifted and used with water, has always given very good results in my experience; but in case of it failing in the present instance, you might try what is known as Turkey dust, or powder, using it with water in the same manner as the core sand. Before commencing to grind in the valves, it is as well to test the truth of the surfaces by smearing the valve with a small quantity of red lead and oil and easing off the hard places with a scraper or smooth file, until both valve and seat bear equally all round.—ROBERT W. FIELDWICK.

SPEED CONES.—I have a speed cone, the diameters of which are 19¾in., 18½in., and 9in. I want the 18½in. to drive a 7in. pulley. Will someone give me a rule for calculating the diameters of the other two pulleys?—W. S. M.—*A.*—In order that the belt may run equally tight on each speed, the sum of the diameters of each pair of pulleys must equal the sum of the diameters of the pair of pulleys given—viz., 25½in. The diameter of the smallest pulley is 25½in. − 19¾in. = 5¾in. diameter. The diameter of the largest pulley is 25½in. − 9in. = 16½in. diameter. The complete set of cones is as follows :—

in.		in.		in.	
19¾	……	18½	……	9	driving.
5¾	……	7	……	16½	driven.

The sum of each pair being 25½in.—ROBERT W. FIELDWICK.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed

6th January, 1893.

324 SUPPORTING BLOCKS for USE WITH MACHINE TOOLS. E de Pass. (*La Société Alsacienne de Constructions Mécaniques* France.)

330 STEAM BOILER and OTHER FURNACES.* O D Orvis.

333 PACKING RINGS for STEAM MACHINER R Macintyre.

7th January, 1893.

344 HEATING WATER or OTHER LIQUID by MEANS OF ELECTRICITY. B P Scattergood,

317 APPARATUS for ENGRAVING METAL CYLINDERS and PLATES. D M'Dougall.
351 NAUTICAL RECKONING or INDICATING INSTRUMENTS. G C Marks. (*N R Oliver*, India.)
359 PNEUMATIC PUMP REST. W H Bryant.
362 ENGRAVERS' RULING MACHINES. E Fanshaw.
365 SURFACE CONDENSING STEAM ENGINES. J Weir.
379 STEAM or OTHER MOTIVE POWER ENGINES. G Hughes. (*J Smith*, United States.)
380 CAR COUPLING. W W Horn. (*V B M'Donald*, United States.)
383 FIREBARS. W T Kendall.
387 COMBINED ELECTRIC LAUNCH and SAILING VESSEL.* K D Bowens.
391 ELEMENTS for ELECTRIC or SECONDARY BATTERIES. E Hancock and A J Marquand.
392 BLOCKS or BRIQUETTES of FUEL. T W Lees.
394 VALVE for ACTING AUTOMATICALLY for DRAINING STEAM CYLINDERS and PIPES of WATER. F Lamplough and J A Bauer.

9th January, 1893.

398 BOX-MAKING MACHINERY. W Ward.
400 COMPOUND SUPPLEMENTARY and SAFETY GOVERNOR. G F Alder.
402 AUTOMATIC CUT-OUT for SERIES INCANDESCENT ELECTRIC LIGHTING. A P Donnison and M H Barber.
408 BRIDGES of BOILER FURNACES. W Eyre.
413 METALLIC PACKING for PISTON RODS. T J Carr.
414 STOPPING and RESTARTING TRAMCARS. E Chadwick.
418 MILLS for CRUSHING, PULVERISING, and SIEVING METALLIFEROUS ORES. J T Walton.
424 APPARATUS for PREVENTING or SUPPRESSING SMOKE in the FURNACES of STEAM BOILERS. S Bond and W Jackson.
432 HYDRAULIC AUTOMATIC ENGINE and PRIME MOVER COMBINED. T Dowling and J H Wince.
434 MODES of DRIVING CLOCK MECHANISMS. R H Twigg.
439 PRODUCTION of VACUUM. J Dewar.
442 ELECTRIC LIGHTING of GAS ENGINES. T Carlo.
446 INSTANTANEOUS STEAM or VAPOUR GENERATORS. A Nosbaume and A Reis.
449 ELECTRIC MOTORS. I E Storey.
453 SCREW PROPELLERS.* A Rateau.
456 STEAM ROAD ROLLERS. J G and J Allen.
457 COATING of WIRE by ELECTRO-DEPOSITION. S O Cowper-Coles and the Metallurgical Company Limited.
458 FORMING, SHAPING, or SPINNING of METAL BODIES. E Polte.

10th January, 1893.

471 VARIABLE SPEED ELECTROMOTORS.* C A Allison. (*C Hering*, United States.)
473 STAMP BATTERIES for the CRUSHING of GOLD or SILVER ORE or QUARTZ. F Freeman.
483 RAILWAY SIGNALLING. C K Sagar.
485 LUBRICATORS. W Boby and H W Bowden.
487 HEATING STEAM BOILERS. J A Yeadon.
491 TUBES and TUBE-PLATES of the MULTITUBULAR TYPE of MARINE or LAND BOILERS. W B Cumming and A Webster.
498 OBTAINING and SEPARATING SULPHIDE of NICKEL in the TREATMENT of MATTES CONTAINING COPPER, NICKEL, IRON, ETC.* W P Thompson. (*J L Thompson*, United States.)
499 OBTAINING and SEPARATING SULPHIDE of NICKEL for USE in METALLURGICAL OPERATIONS in the TREATMENT of MATTES of COPPER, NICKEL, IRON, ETC.* W P Thompson. (*R M Thompson*, United States.)
500 AUTOMATIC TRAIN BRAKES.* F Williams.
505 DUPLEX PUMPING APPARATUS. P F Oddie.
510 ELECTRIC TRANSMISSION of POWER.* E de Pass. (*E W Rice, jun.*, United States.)
511 COATING ALUMINIUM and ALUMINIUM ALLOYS.* G Wegner and P Gührs.
512 SOLDERING ALUMINIUM and ALLOYS of ALUMINIUM.* G Wegner and P Gührs.
516 MEASURING and RECORDING INSTRUMENTS for ELECTRIC CURRENTS.* H H Lake. (*E Weston*, United States.)
517 INSTRUMENTS for MEASURING ELECTRIC CURRENTS.* H H Lake. (*E Weston*, United States.)
518 APPARATUS for MEASURING ELECTRIC CURRENTS.* H H Lake. (*E Weston*, United States.)
519 ELECTRIC RESISTANCE BOXES or COILS.* H H Lake. (*E Weston*, United States.)
520 APPARATUS for MEASURING and INDICATING ELECTRIC CURRENTS.* H H Lake. (*E Weston*, United States.)
521 PULLEYS. J Walker.
531 FURNACE LAMPS for OIL and GAS ENGINES. A and F Shuttleworth and W H Tyrrell.
543 COMBINED AMMONIA DISTILLING and REFRIGERATING APPARATUS.* J E Fuller.
545 COUNTERBALANCE and GUIDE for RECIPROCATING MECHANISM.* M N Forney.
550 PULLEYS. A Guild.
551 DRILL BITS for USE with PERCUSSION ROCK DRILLS.* C W Burton.
553 GAS or OIL MOTOR ENGINES. F W Crossley.
554 REDUCING-PRESSURE VALVES.* E J Wood.
555 PROCESS of MANUFACTURING GAS.* W P Watson.
556 WRENCHES.* G W Bufford.
557 PIPE WRENCHES.* G W Bufford.
562 ELECTRIC MEASURING INSTRUMENTS. W T Goolden and S Evershed.
563 MANUFACTURE of IRON and STEEL. J M White.
564 GENERATION of STEAM.* W Schmidt.
566 APPLIANCES for CUTTING OFF SCALE from STAYS and PLATES of BOILERS. R J Smith.
575 CAR MOTORS. G Stevenson.

11th January, 1893.

581 PROPULSION of VESSELS. F J Reynolds and J R Porter.
582 SELF-RECORDING ELECTRIC APPARATUS. A Wright.
585 SUSPENDING ELECTRICAL CONDUCTORS by MEANS of WIRES. A E Muirhead.
587 APPLIANCES for OBTAINING MORE PERFECT COMBUSTION of FUEL in FURNACES. S Taylor.
601 ELECTRICAL INCANDESCENT LAMPS. J R Hughes.
605 MEASURING of ELECTRICITY. R Kennedy.
608 GAS and PETROLEUM MOTORS.* L Sabatier and others.
615 SAFETY AUTOMATIC CHECK BLOCK for HAULING GUY, STAY, or PULLEY ROPES and LINES. T M Houghton.
620 SCIENTIFIC SCREW CONVEYER. F Oakden.
621 PREPARATION of LEAD OXIDES and LEAD SALTS DIRECT from GALENA and SULPHATE of LEAD. W S Kilpatrick.
628 BRACKETS, STANDARDS, and OTHER ELECTRIC-LIGHT FITTINGS. H Faraday.
630 INJECTORS.* A Friedmann.
632 APPARATUS for DEPRIVING of UNPLEASANT ODOUR the COMBUSTION GASES DISCHARGED from GAS or OIL MOTOR ENGINES. C D Abel. (*The Gas Motoren Fabrik Deutz*, Germany.)
636 NUT LOCKS.* E E Poole and others.
644 LOCKING NUTS on SCREWS or BOLTS. W Rayner.
647 METAL PLATES.* J B Nau.
652 VALVE GEAR of ROTATIVE STEAM ENGINES. L I Seymour.
659 VARIABLE SPEED GEARING. W W Beaumont.
660 ELEMENTS or PLATES for SECONDARY BATTERIES. H F Kirkpatrick-Picard and H Thame.

12th January, 1893.

670 FURNACES and APPARATUS for the TREATMENT of TOWNS' REFUSE. W Weaver.
672 METALLIC PACKINGS for PISTON RODS. S A Ward.
675 "CONRITE" OFF-SHORE DISTANCE INDICATOR. E Baker.
676 MECHANISM for TRANSMITTING POWER. H F Easton and T A Joyce.
680 BOILERS. T J Thompson.
681 TREATMENT of BLAST FURNACE and PRODUCER GASES, for OBTAINING CYANIDES THEREFROM. J Addie and others.
687 WATER-FILTERING APPARATUS. J Barker.
688 STEAM TRAP. W Lees.
694 AIR-TIGHT ELECTRIC LIGHTING WIRE CASINGS. R Atkinson.
695 LOOSE PULLEYS. G F Chutter.
698 CHAIN GEAR WHEELS, SPUR WHEELS, and PULLEYS. J Cant.
701 MINERS' SAFETY LAMPS. T Morris.
703 APPARATUS for CENTRING SHAFTINGS. W Copley.
712 GINS or PULLEY BLOCKS. D J Morgan. (Partly communicated from abroad by *W G Nixon*, on the High Seas.)
716 EARTH or BASEPLATES for FENCING STANDARDS and COLUMNS. R R Main.
717 APPARATUS for USE in TUNNELLING OPERATIONS. G Talbot.
724 FILAMENTS for INCANDESCENT ELECTRIC LAMPS.* F R Pope.
731 STEAM HAMMERS. P Otto.
735 GAS and OIL MOTOR ENGINES. C D Abel. (*The Gas Motoren Fabrik Deutz*, Germany.)
736 MANUFACTURE of WHITE LEAD and OTHER COMPOUNDS ELECTROLYTICALLY. J C Richardson.
737 VALVE ARRANGEMENT for STEAMSHIPS, STERN TUBES. J S Starnes.
748 APPARATUS for DRILLING or BORING ROCK or METALS. O Terp and others.
751 ALUMINIUM SULPHIDE. C T J Vautin.

13th January, 1893.

757 PLATINISED ELECTRODES. H T Barnett.
758 CARBON ELECTRODES. H T Barnett.
761 PROPELLERS. L J y Puig.
764 CALCULATOR. T Wolstenholme.

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BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

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FRIDAY, FEBRUARY 3RD, 1893.

The Value of the Steam Jacket.

FROM the report of the Research Committee of the Institution of Mechanical Engineers, which we recently published, it would appear that the practical value of the steam jacket is altogether beyond dispute. While, however, we are not prepared to altogether admit that this is so, it must be confessed that the results of the most carefully conducted experiments appear to point to the same conclusion. One important test not included in the Research Committee's report is that of a Worthington high-duty pumping engine, carried out by Professor Denton, the details of which were given in the Transactions of the American Society of Mechanical Engineers, 1891. The engine, which was used for pumping crude petroleum through a 30-mile section of the Standard Oil Pipe Line, was of the tandem compound type, with a receiver between each pair of high and low cylinders, the steam being heated while passing through a receiver by contact with a nest of piping filled with steam at boiler pressure. Both the barrels and heads of all cylinders were jacketed with steam taken directly from the boiler. Steam for the jackets and the reheater in receiver was taken from the main steam-pipe by a 1½in. pipe leaving the bottom of the latter immediately under the main throttle valve. From this pipe, branch pipes, 1½in. diameter, led steam to the reheater and jackets. The drainage from the reheater passed through the cylinder jackets, and the drains from the latter all united in a single pipe underneath the cylinders, leading to a steam trap in the case of the test, but to an automatic steam return trap on top of the boilers in the ordinary running of the station. At one period of the test steam was shut off from the jackets and reheater. The engine was then run one hour and a half. The stroke was very irregular, and the revolutions dropped from 20·13 to 16·6 per minute, and the oil pressure from 850lb. to 750lb. The indicator cards were very irregular from water in the cylinders, but occasionally a well-formed card could be obtained. The water consumption per horse-power was increased 20 per cent., but as less work was being done, the coal consumption did not noticeably increase. Further experiments were made, and on the second occasion when the jackets were shut off, the speed fell from 22·05 to 20·2 per minute. After seven minutes' running, the water in one low cylinder could be heard to splash as the piston reached the end of its stroke. The vacuum fell from 27½in. to 23in. After running an hour, it was evident that the water in the cylinders was still increasing, although the pump was still under good control. Five minutes after restoring the steam to the jackets, the full vacuum had returned, the sound of the water in the cylinders disappeared, and the engine regained her speed. The indicator cards show about 20 per cent. less mean effective pressure in the low cylinders and about equal mean effective pressure in the high cylinders, compared with the cards taken with steam in the jackets and reheater. We think, with Professor Denton, that such results as these conclusively prove that the use of steam jackets is undoubtedly necessary to the successful operation of this particular type of engine.

Electrical Progress.

IN his presidential address last week, before the Institution of Electrical Engineers, Mr. W. H. Preece, F.R.S., referred at considerable length to the progress made in the various applications of electricity during the past 40 years, a period during which he has been engaged in developing such applications. Telegraphy, which is one of Mr. Preece's strong points, first engaged his attention, and he traced the gradual growth of that branch and that of telephony. In his opinion, the rapid development of the electric light had been retarded by the rapacious financial promoter, who had ruined the prospects of private enterprise, and had rendered necessary the legislation which would place, and in some cases had placed, that industry in the hands of local authorities. This is quite correct, and we are glad to note that progress is now being made in reducing the cost of producing electrical energy. If a full load, remarked the speaker, could be maintained during the whole twenty-four hours, electrical energy could be manufactured for one-third of a penny per supply unit, and that was equivalent to gas at 2d. per 1000 cub. ft. This is a bold and startling assertion to make, one which will be called into question, and which, moreover, constitutes a dream of the future. Until the use of electromotors is extended—and at present the number energised from central stations in this country is practically nil,—there seems little possibility of all the plant in generating stations—excepting that held in reserve—being worked the whole of the twenty-four hours. It is the load factor which is the trouble of the central-station engineer, and if a full load could always be obtained, electric-light companies would be among the most prosperous undertakings. Mr. Preece gives the number of lamps now fixed in the metropolis as 500,000, as against 145,000 in 1890. He expressed the opinion that the streets of many towns could be illuminated by the streams running past them, but fear and distrust had yet to be removed from the minds of the local authorities. Reference to the electrical transmission of power, and to the growth of electric tramways and railways, brought the address to a close.

The Manufacture of Tool Steel.

NO small amount of interest is at present being manifested in a new process of converting low-grade steel into high-class tool steel. The process, which appears to be of American origin, has been developed in this country, and is at present being employed at the Phœnix Engineering works, Stoke-on-Trent. The system is carried out by placing bars of Bessemer or other steel, containing a low percentage of carbon, in a specially-designed furnace and subjecting them to a high temperature while embedded in a carbonaceous compound of special character. Many tons of steel have been converted in the furnaces at the above works, and a number of tools have been made from the converted steel, both by this firm and by the proprietors of other engineering works to whom the steel has been supplied, and in all cases the tools thus made have turned out exceedingly well. Exhaustive tests of the system have lately been carried out, and tool steel converted from such brands of low-grade steel as Bessemer, Glengarnock basic, Brown, Bayley and Brymbo steel, costing on the average £7 per ton, has been found to compare favourably with the best tool steel known. Of the turning tools made several were set to work, one in particular being put to redress the steel tyre of a railway wagon wheel, the skin of which had become very hard and dense by reason of the many thousand miles it had travelled. The tool went through its work most satisfactorily, taking two good cuts off the tread of the wheel. This tool was made from steel costing £7 5s. per ton. Another turning tool made from similar steel was put to work upon another wheel, with a particularly hard skin, as was shown by the turnings, which were short and chippy. This tool took 5½in. off the tread and flange of the wheel before it required regrinding. There seems every likelihood of a revolution occurring in the steel trade should the fullest expectations of the inventor, Mr. F. G. Bates, be realised.

Electric Signalling to Balloons.

A RELIABLE method of signalling at altitudes for military and naval purposes has for many years been recognised as essential, and it is generally understood that no army or navy can be said to be properly equipped without some such arrangement. A system which, it is claimed, is superior to those methods of signalling by reflecting intermittent beams of light upon the clouds, by means of rockets, or by captive balloons with flags, etc., was described in detail on the 27th January, before the Royal United Service Institution, by the inventor, Mr. Eric Stuart Bruce. The principal features of the system lie in the facts that the car of the balloon is dispensed with, and the signals are flashed by electricity to the captive balloon. Thus, by this arrangement, a captive balloon can be used for signalling, and of such a size as to be portable, quickly inflated, and easily manipulated. The balloon is made of thin cambric, and is coated with varnish of a light colour, thus forming an exceedingly translucent medium. The balloon is filled with pure hydrogen or coal gas, and contains usually six incandescent lamps, which are connected by means of a cable to a source of electricity on the ground; and in the circuit on the ground is an apparatus for making and breaking contact rapidly. It will readily be understood that by varying the duration of the flashes of light in the balloon, it is possible to signal according to the Morse or any other code. To show the facility with which this can be accomplished, Mr. Bruce, by means of a model balloon, caused the sentence "Bridge repaired" to be flashed to it. The signals were transmitted by means of a key resembling, though differing from, a Morse key. It has carbon contacts which can easily be renewed at slight expense, and that type of key has been adopted by the Belgian Government. The key is arranged on a switchboard, so that the current can be turned on to the lamps in the balloon either through the key or directly for continuous illumination. The speed of signalling depends upon the thickness of the carbon filaments in the lamps, and by the use of very thin filaments it was possible to attain considerable speed. The lamps are suspended inside the balloon in a holder resembling a ladder; they are of 8C.P. nominally, but give good results when worked up to 16C.P. When tested at the Albert Palace, Battersea, the signals from a balloon fitted with six 8C.P. lamps were visible at Uxbridge, a distance of 16 miles. From his experience Mr. Bruce has found that the continuous flashing of the lamps does not shorten their life. He uses storage cells for energising the lamps. The battery consists of 25 cells, weighing 5½cwt., and occupying a space of 3ft. by 1ft. 8in. The hydrogen gas employed for inflating the balloon is compressed and carried in cylinders. Several balloons on this system have been made, and one has been tested by Government officials at Chatham. Mr. Bruce concluded his description by making various interesting experiments to show the absolute safety of the arrangement of incandescent lamps in a balloon filled with gas, and the hope was expressed that the Government would adopt the system.

The Smokeless Combustion of Coal.

UNDER the above heading is announced from Berlin an invention which, if as successful as anticipated, will bring about a great revolution in steam-producing practice. The scheme is to "reduce to powder, by means of the ordinary centrifugal mill," the whole of the coal consumed, and to inject this by a blast of air into the furnaces, from which the firebars and other internal fittings have been removed. By this means it is hoped that each particle of coal, being completely surrounded by the due allowance of air, will be as completely consumed. The process of thought by which the method may have been reached is in this case easy to trace; as, on the one hand, in the modern use of petroleum in steam boilers, a jet of compressed air or steam sprays the combustible into the furnace; and, on the other hand, in the use of coal we have many varieties of mechanical stokers which use "slack," or semi-pulverised coal, and many of these scatter the coal much in the form of a spray. In saying this we have no wish to depreciate the invention or its merits, but only to show how reasonable an advance it is on methods which have had a fair trial. While approving, however, of the system as a coal-consuming method, we have grave presentiments as to its working *in toto*. If large quantities of an absorbent powder are packed into the confined bunkers of a steamer, there would be a danger of serious swelling in the mass, and if put in at all damp an infinitely more serious danger of spontaneous combustion. It is at present often considered necessary or prudent to use miners' safety lamps when entering bunkers, and under the new system it will be still more imperative to adopt the most refined precautions. Again, it has been proved that in coal mines explosions may be caused by an excess of minute particles of coal in the air, without fire-damp being present. The company who have taken out the patent have already made contracts with the three largest marine engineering concerns in Germany to work it. These are the Vulcan Works in Stettin — the largest and best-equipped marine works in Germany,—the North German Lloyd, and the Hamburg-American steamship companies.

Proposed Electric Railway in Brussels.

IT is proposed to construct an electric railway in Brussels to connect the most important points in the town. The promoter of the scheme is Mr. A. Müllender, vice-consul of the United States at Liege, and who gives the following particulars of the projected railway. The line would be underground, and would comprise a belt or circle railway. There would be eleven stations, which would be reached from the surface by means of electric lifts, and *vice versâ*. The maximum gradient is 2 per cent., and a uniform fare of threepence in first and twopence in second-class carriages would be instituted. A three minutes' service of trains would be arranged, and the complete circuit of the town would be accomplished in fifteen minutes. This seems to be an instance of a consul in a foreign country endeavouring to promote largely the interests of the country he represents.

Machine Construction.

THE CONSTRUCTION OF MACHINE ELEMENTS.

Continued from page 23.)

A CONCEALED form of universal joint is that used in rolling mills, the cross being formed upon the end of the roller.

Fig. 436 shows a form of link coupling designed by the author. A is the driving, and B the driven shaft, the arm C being jointed at 3 by journals at right angles to

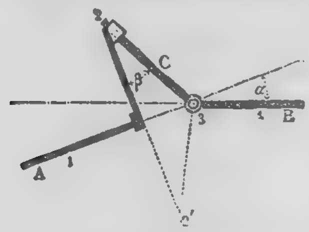


FIG. 436.

B, while at 2 it slides in a bearing rigidly attached to A. The axis B makes with A an angle a, and the piece 3 C 2 makes with A the angle $90° = \beta$. For the relation between the angular rotation ω_1 and ω_4 of the shafts A and B, which are supposed to revolve in fixed bearings, we have:—

$$\left.\begin{array}{l}\tan\omega_1 = \tan\omega_4\left(\cos a - \dfrac{\sin a\tan\beta}{\cos\omega_1}\right)\\ \text{or,}\\ \tan\omega_4 = \dfrac{\sin\omega_1}{\cos a\cos\omega_1 - \sin a\tan\beta}\end{array}\right\}\quad(145)$$

Here the counter-weights are omitted, and the parts C_1 and C_2 connected on both sides. Clemens has used this form with the angle $2a = 90°$. The doubling of the parts has the objection that it requires more accurate fitting of the parts than where only one side is connected. If the axis B is placed parallel to A, as at B′ in Fig. 437, the rate of motion will be very irregular, for $a = \beta = 30°$, as in the illustration. The velocity ratio will vary between $\frac{1}{2}$ and 2.

In many screw vessels a simple form of flexible coupling is used, suited for slight angular variations. In Fig. 440 this is shown, and it will be seen to give slight flexibility similar to the universal joint, and sufficient for many cases. A bearing should be placed back of the coupling on each shaft.

III.—CLUTCH COUPLINGS.

§ 156.

TOOTHED CLUTCH COUPLINGS.

Couplings of this form may be distinguished by their method of engagement, the clutch surfaces entering in and out of engagement axially, radially, or inclined.

The oldest form of clutch coupling, and one of the most widely used, is that shown in Fig. 441. Here the engagement is axial. The modulus for the proportions is the same as before, $\delta = \frac{1}{3}d + \frac{3}{16}$in.; and an approximation to the number of teeth may be given by making $z = 1 + 0{\cdot}6\ d$. The clutch is thrown in and out of gear by a lever which works in the groove in the portion of the clutch on B. Examples of suitable lever forks are shown in Fig. 442.

Various forms of clutch teeth are used. The forms in general use are given in Fig.

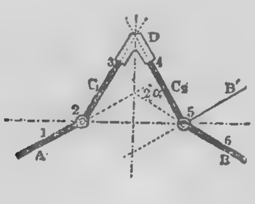


FIG. 437

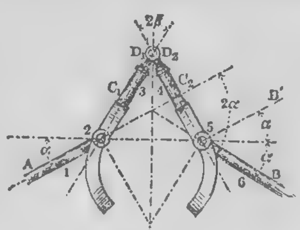


FIG. 438.

In this case the transmission of motion is much more irregular than with the universal joint, since the angular velocity ratio between

$$\frac{1}{\cos a \mp \sin a\tan\beta}\ \text{and}\ \frac{\cos a}{1 + \sin^2 a\tan\beta}$$

fluctuates. This coupling is really only a

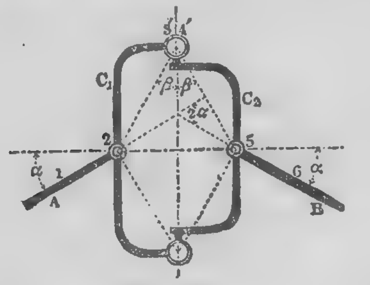


FIG. 439.

modification of the universal joint, inclined to such an extent that the fork of the shaft A stands at right angles to the axis. [Compare formula (144) with (145)]. By combining two such couplings symmetrically

443. The first form is adapted for motion in either direction, but can only be operated when moving slowly. The second form is more readily thrown into action, but is adapted to transmit motion only in one direction. The driving faces are inclined very slightly, from the normal to the direction of motion, the angle not being enough to cause any tendency to disengagement. In the third form the teeth are more blunt in shape at the point, which adds to their strength against breakage when subjected to shock. The last form is a combination of the preceding varieties, and, like the first, may be driven backward. In spinning machinery, light couplings with many fine teeth are used and operated at high speeds. In some screw vessels in which there is no provision for raising the screw, it is desirable to disconnect it when proceeding under sail alone, and some form of clutch coupling is used. A very simple form is the so-called "cheese coupling" used in English vessels, Fig. 444. The hub of the propeller is provided with a bearing on each side, and formed with a T projection fitting into a corresponding recess in the heavy flange (or

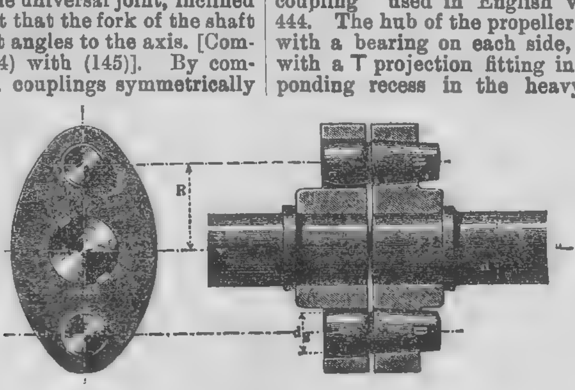


FIG. 440.

with each other, as in Fig. 437, the motion will be uniformly transmitted. The two sleeves at 3 and 4 are formed in one piece, their axes making the angle 2β with each other. In practice it is better to make these parts in the form of journals, and place the sleeves in the C_1 and C_2 (Fig. 438). These parts are also prolonged beyond the shafts in order to counterbalance the weight. The pieces 3 and 4 can be bolted firmly together, since their relative position to each other is constant. It must be observed that a must not exceed $90 - \beta$, otherwise a dead point will occur.

The parts 3 and 4 may also be connected by ball joints 3′, 4′ (Fig. 439), in which case the device becomes the coupling of Clemens.*

* Clemens' angular shaft coupling, U.S. Patent, Nov. 10, 1869.

cheese) on the shaft A. The propeller blades are secured to the hub as already shown (Fig. 191).

(To be continued.)

ON the 26th ult. the powerful new hopper dredger "Southampton," constructed by W. Simons and Co., Renfrew, to the order of the London and South-Western Railway Company for the improvement of the port of Southampton, underwent the steaming and dredging trials on the Clyde with most satisfactory results. The buckets have a capacity to raise over 500 tons of material per hour, and to dredge to a depth of 40ft. below the water level. This firm has also received an order from the Crown Agents for the Colonies to construct a 460-ton hopper dredger for Antigua.

Mr. Tomlinson on the Breakdown of the "Umbria."

AT the last fortnightly dinner at the Engineers' Club in New York, Mr. Lawrence Tomlinson, engineer-in-chief of the "Umbria," who was a guest of the club, made the following remarks when answering to the toast drunk to his health:—

the rings or collars on each side of the flaw, so I decided to cut out gaps in these rings and drop in these steel bolts and hold the shaft together, and as well transmit the power of the engine through them to the other end of the shaft. It was a slow and tedious job to cut these gaps 6in. deep, through hard steel collars 3½in. thick. We had plenty of broken drills and chisels

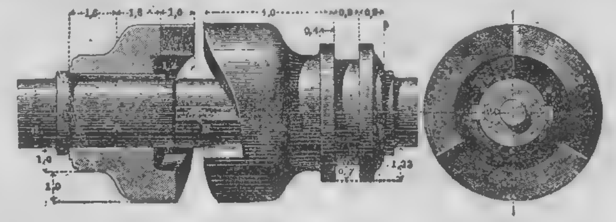


FIG. 441.

After having been at sea for several days and combating heavy weather, it was found that the driving or thrust bearing on one of the sections of the main shaft was unduly heating. After doing what all engineers do under such circumstances, it was found impossible to lower the temperature of the shaft and bearing, and the engine was slowed down. This, after a few hours, was found to improve the condition of affairs somewhat, and the engine was again put up to its normal speed, when the heating of the parts came back again, and at last steam was

before we had chopped out these recesses. But at the end of 24 hours we had one bolt in. I had planned to put in five bolts equally spaced around the shaft, but as I found it would add two more days to the delay, I reduced the number to three, and concluded to take the chances rather than further delay the ship, drifting as she was out of her course.

In addition to the labour incurred in preparing the shaft, I found that there was a heavy rib in the thrust bearing that would not allow the nuts on the bolts,

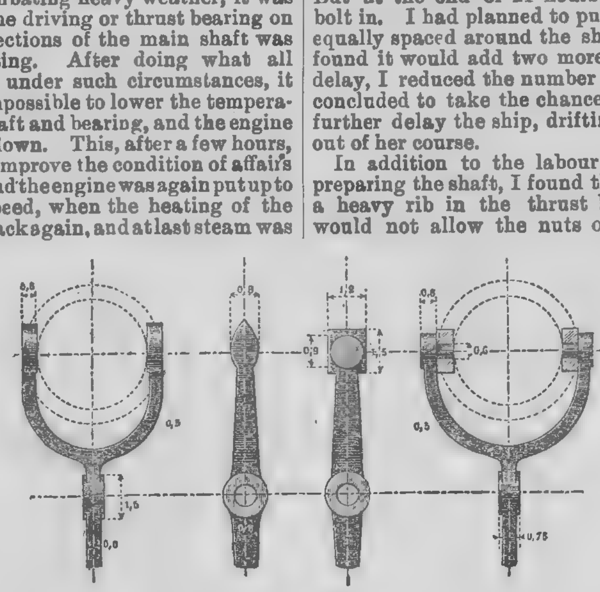


FIG. 442.

shut off, and the engine brought to a standstill. I then directed that the cover should be hoisted off the bearing that had given us so much trouble, when I saw a formidable fracture in the shaft, between two of the driving collars or rings. After gathering together my chief assistants, I said to them, "You now see what is the matter. I shall now leave you for ten minutes, in order that you may consult among yourselves in regard to the situation, and when I return if anyone has any plans to propose, or suggestions to make, I will be glad to listen to them." At the end of the ten minutes I

which were 4½in. deep, to go around with the shaft, so we had to split or cut the nuts in two pieces, so as to make them only 2½in. thick, and also cut off the end of the heavy bolts. All this, as you know, was no easy job with the tools we had to work with; but pluck and determination have pulled many an engineer out of difficulties, and so it did us, and at the end of 72 hours of unremitting labour, by all hands, we were ready to turn on steam and give the shaft a trial. As the crack in the shaft was an oblique one, thus pushing one part ahead of the other, I concluded that I

FIG. 443.

went back into the tunnel shaft and asked them if they had thought of any plan by which to get out of the scrape we were in. All shook their heads and said they did not believe that anything could be done by which the ship could made headway while that broken shaft was in her. "Well, lads," I said, "I will tell of a way to do it," and taking a piece of chalk out of my pocket (the chalk age not yet having passed away) I marked on the bulkhead a section of the shaft, and the plan I had for temporarily repairing it; and I am proud to

ought to screw up the 6in. bolts as hard as I could; but there is where I made a mistake, for on starting the engine and gradually increasing its speed to 30 revolutions per minute, the head of one of the bolts flew off. I had to shut down again, and we had to prepare another bolt and put it in place of the broken one. But, as usual, we had learned something, and that was, that when the nuts were hove up hard, there was an additional strain brought on the bolts, by the twisting of the shaft, which they could not stand, so that

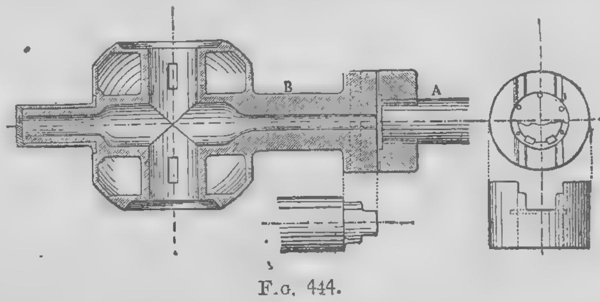


FIG. 444.

say that, as they looked upon the sketch, and on the shaft, and saw what a lot of hard work there was before them, not one flinched, but all were ready to go at it at once.

And so we gathered up what tools and appliances we had and started in upon what I am sure everyone here knows was a hard and long job, as we were fixed. We had on board some heavy, tough steel bolts 6in. in diameter, and long enough to take in

when the new bolt was put in it was not screwed up so very hard, and the others were slackened off a bit, and we started again and gradually got the speed up to 10 knots an hour. At last we reached New York, when we all gave a long breath of relief, and took a good long sleep of rest.

If you will permit me to trespass still further on your kindness, I will say a word about the company who own the "Umbria." Beginning in their service when

I was but a lad, serving as I did my apprenticeship under them, working for them as a journeyman, filling as I have all the various grades as an engineer on their ships, sailing with them in various parts of the world and in many seas, for 40 years of my life, I want to say that I have always found that if a man in their employ did his duty fairly and honestly, they not only recognised it, but advanced him. I have always found that they have been considerate of all who were in their service, and careful of all who, as passengers, entrusted their lives to their care as they sailed the seas over under their colours.

The Under-type Stationary Engine.—XXIII.

In previous articles we have dealt somewhat severely with the makeshift fittings adopted by some boiler-makers; we purpose illustrating a few approved types.

Fig. 46 shows a sectional view of a right-angle boiler stop valve. The casing is generally made of cast iron; the valve and

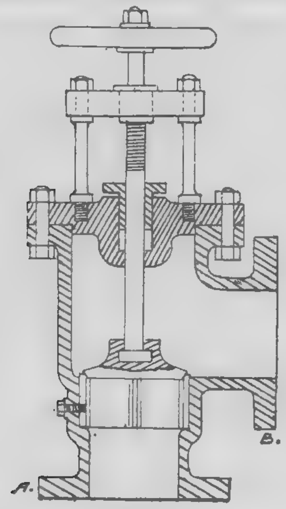


Fig. 46.

seat, gland and spindle, are made of brass. The nut for the screwed part of the spindle is often let into the cover in the steam space, and out of sight, and, we may add, out of mind. But the nut should always be placed outside, carried by a cross-bar and two turned pillars as shown. Steel spindles are far more reliable than brass ones, and as they are in contact with a brass nut for the screw, a brass gland for the stuffing box, there can be no objection to their use. The collar for lifting the valve at the bottom should be forged with the spindle, as shown in our illustration Fig. 46. To do this, it is

Fig. 47.

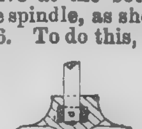


Fig. 48.

necessary to make the outside diameter of the square thread on the spindle the same diameter as the lower part of the spindle, so that the gland can pass over it. The spindle above the nut in the cross-bar must be turned down to the same diameter as the bottom of the square thread. Fig. 47 shows the top of the valve intended for the solid collar. Fig. 48 shows the usual loose collar and taper pin, which should not be adopted, because it is a weak and unsatisfactory job. This loose collar and the inside nut for the screw are the culprits connected with most of the stop-valve accidents. A small set-screw is shown for

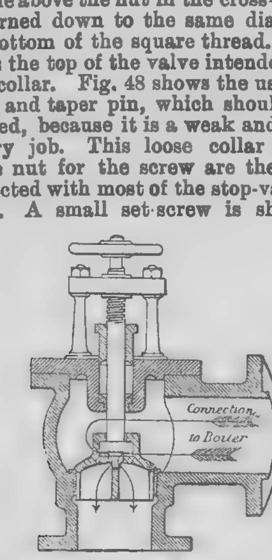


Fig. 49.

holding the brass seat in its place, but this should not be necessary if the seat is made a good fit. Engineers cannot agree respecting the side of the valve which should be open to the boiler steam. If the stop valve Fig. 46 is attached to the boiler seating by the flange A, the pressure of the steam will have to be resisted by the screw and nut of the spindle, and accidents have happened to stop valves having inside nuts; they have been worked until the threads were badly worn, and the load on the underside of the valve has caused the thread to give way, showing the importance of having outside nuts, in which any wear could be easily detected.

"It is also very difficult to shut steam off completely with large valves, when the pressure is on the underside. On the other hand, if the stop valve is attached to the boiler block or on to the end of the steam drum by the flange B, should the threads of the nut strip, the valve would be closed, and no danger arise."—The Mechanical World, January 15, 1892.

With large valves, however, the pressure on the top may become enormous, and require a very large hand wheel to open it. This objection is, however, obviated by having an auxiliary valve in the centre of the main valve, as shown by Fig. 49. The object is to admit the steam very slowly on first opening the valve, and to avoid the strain thrown upon the spindle when force has to be applied to tear the valve off its seat, when the valve is in that position technically called "steam jammed." The end of the spindle, as now generally in use, may be recessed in the lathe so as to leave a broad flat face, corresponding to another facing round an aperture in the top of the stop valve, for the purpose of admitting steam when the spindle is raised through the clearance, which is equal to the area of the aperture left in the buckle or connection into which the end of the spindle is shipped.

Mr. Cormack, some time ago, reported the satisfactory working of a number of valves fitted by him in this way, and remarked upon the very short time usually required to place the main valve *in equilibrio*, when it can be raised without effort, and he stated that an 8in. hand-wheel was found quite large enough for a large-size stop valve. The diameter of aperture found to answer very well is about one-sixth the diameter of the valve itself, so that ¼in. clearance is usually enough.

Attention was claimed on behalf of the auxiliary valve for five reasons—viz., safety, utility, cheapness, ease of adaptation to existing valves, and non-liability to get out of order. Fig. 49 shows the action of the spindle just lifted, the arrows showing the direction of the steam previous to the opening of the main valve.*

Fig. 49 shows a strong, well-designed and snug type of valve, possessing some good features worthy of notice. The globular shape is often adopted in this example. The cover is arranged close to the inlet branch, but it has the objection that some studs must be used for securing the lid, instead of bolts all round, as shown by Fig. 46.

For very large boilers of high pressures, wrought-iron and cast-steel stop valves have been used, but cast-iron ones well strengthened with ribs will do very well for the majority of cases. Care must be taken in the arrangement of the steam-piping so as to avoid any strains being thrown on to the stop valve; the piping being of wrought iron, and having every provision made for expansion.

Several good examples of straight-way stop valves appeared in The Mechanical World for January 1 and 15, 1892, so we need not illustrate one of these.

An anti-priming or collecting pipe must be placed inside the boiler, in communication with the stop valve, of the same inside diameter as the valve, and of such a length as can be conveniently applied, depending upon the position of the stop valve seating on the boiler, and the position of the manhole. The pipe has holes or slots cast in its upper surface, the ends being stopped up, and one or two holes drilled in the bottom for drainage. The pipe is placed as high up inside the boiler as possible. The steam being collected at different points along the pipe, there is less tendency for moisture to be carried with the steam. The combined area of the holes must be about 25 per cent. in excess of the area of the stop valve. When steam domes are used, collecting pipes may be dispensed with.

The seatings on the boiler for the stop valve and the safety valve should be of the same diameter, so that by altering the position of the anti-priming pipe, the stop valve may be placed in the most convenient position.

A very useful and reliable type of stop valve is made on Robinson's patent, by Messrs. Bell's Asbestos Company. A packing ring of asbestos is secured in the valve, so that the steam-tight joint is not affected by grit, mud, expansion, contraction, or uneven seating. It cannot stick fast, owing to the movement of the loose centre.

By the insertion of a new asbestos ring, which occupies a few minutes and costs a few pence, the valve will be again equal to new. The valve is so well known that no illustration is needed.

(To be continued.)

* "Engineering," March 22, 1878.

The Transmission of Power by Compressed Air.†

There is an ever-increasing tendency in modern town life to make use of every possible means for reducing labour and cheapening the production of all those articles and things which go to make up the sum of the luxuries and necessities of our complex existence; and, as far as the mechanical progress of the times goes, there appears to be a decided tendency towards centralisation. In Manchester very rapid progress in this direction is now being made. For many years we have been content to get our water from what may be called a central station, and our gas from another; but now we are rapidly approaching the time when electricity and hydraulic power will both be obtainable from a central source. The benefits which

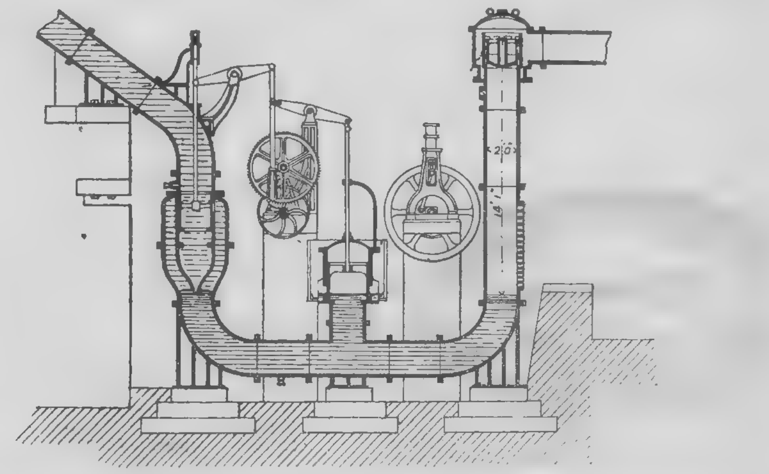


Fig. 1.

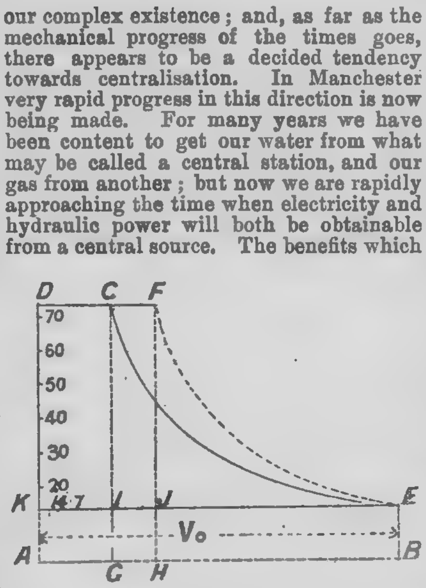


Fig. 2.

might be made to accrue from this centralisation of the production of modern necessities are many; but, while the possibilities are great, the need for careful management on the part of the authorities is also great. Too much reliance upon the municipal method of management will probably lead to future disappointment, especially when a large proportion of the more general wants of the public will be supplied directly by the local authorities.

The experience which has been gained during recent years in Hull, London, and others towns where high-pressure water has been distributed through wide areas from a central pumping station, proves that such a method of power distribution has supplied a want, and is more economical than what might, for distinction, be named the individual system of supply. But while hydraulic power is admirably adapted for driving slow-moving mechanisms and hoisting gear, there is, nevertheless, a limit to its adaptability, and that limit is soon reached when loads are variable and speeds considerable.

Mr. Ellington, who is one of the staunchest advocates of the hydraulic system, as well as one of the most experienced engineers in its use, states that the efficiency of a slow-moving hydraulic machine, such as a hydraulic press with one gland or packing leather, will be about 90 per cent., while a rapidly-moving lift will not give more than 50 per cent. efficiency. Taking these efficiencies of the individual machines, and deducting the efficiencies of the engines and pumps at the central station and the efficiency of transmission through pipes, it will be seen that for every horse-power of work done by an ordinary lift, 2½H.P. will have to be indicated in the steam cylinders at the central station. It is clear, therefore, that the hydraulic system, though admirably adapted for the transmission of power to slow-moving, evenly-loaded, and intermittently-working machinery, soon falls short of commercial possibility when speeds are higher, loads variable, and constant working desirable.

In order to cover the whole range of modern requirements, some other method suitable to these altered conditions is desirable.

It is to such a system that your attention will be directed for a short time this evening, and afterwards I trust that you will agree with me, that for extreme handiness, universal suitability, and ultimate economy, few systems are equal to it.

In the face of the general impression that transmission of power by compressed air is extremely costly, it may be considered to be rather bold to make the assertion contained in the preceding sentence; but after an extensive acquaintance with the subject, and frequent investigation into the causes of the costliness of the system, I can say that a very large proportion of the compressed-air plants in England and abroad—particularly in England—have been put up under the fallacious idea that, because the system is thought to be an expensive one, therefore it is of no use to take the most ordinary care to design compressors better than those that have gone before.

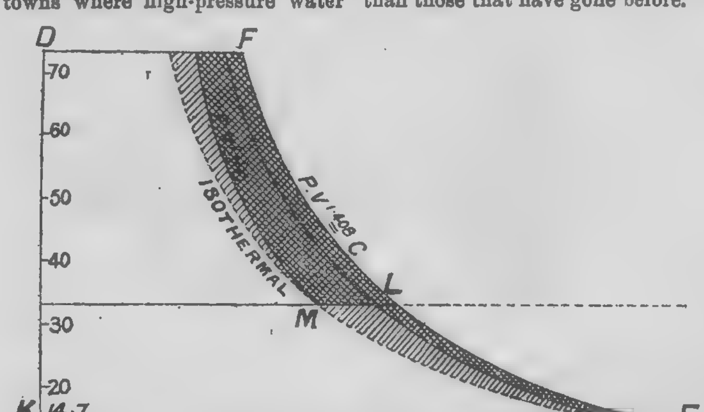


Fig. 3.

Wherever you go you hear the same story: "Well, yes, we have a large plant, and there is no doubt of its safety, ease of manipulation, simplicity of the motors, and small wear and tear; but it is very costly in fuel, and wasteful."

An inspection of the compressors mostly accounts for the greater part of the

† Paper by Mr. W. J. Jenkins, A.M.I.C.E., M.I.Mech.E., read before the Manchester Association of Engineers, January 28, 1893.

complaining. You will frequently find the steam engine arranged so as to cut-off at ½in. of the stroke, because it is assumed that as the greatest resistance in the air cylinders occurs near the end of the stroke, therefore steam must be carried a long way into the steam cylinder to make up for it; yet you will find engines close at hand working against a constant load with a tenfold expansion.

It is curious to observe the fixity of ideas when once they have been formed, for in one case it never seems to strike the user that if his fly-wheel will equalise the fluctuating energy given out in the steam cylinder with a cut-off of ⅒th, it will also do the same with his air compressors. Then you will nearly always find the suction valves of the air cylinder too small for their work; and worse still, the delivery valves will be loaded with a spring to such an extent, and the area of outlet will be so restricted, that the air cannot get out of the cylinder fast enough, with the result that an excess resistance of 10, 20, and even 40lb. per square inch is thrown upon the piston and wasted in heating and friction.

To use the words of a Continental writer, it often happens that "owing to the bad design of the compressors, three-fourths of the power to be transmitted is lost before the air enters the mains, and before there can be any talk of transmission." It should not be a matter for wonder if, under such conditions, the ultimate efficiency of the system is low. But the compressors are not the only faulty parts of the apparatus, for the mains are generally far too small, and the motors are nearly always converted steam engines of the simplest and most wasteful type.

As the compressors are the first step in the series of machines used in a system of transmission of power by air, it would perhaps be best to direct attention to them first. The time we have to spare this evening will not permit of any kind of historical retrospect, so I propose only to allude to the machines of the past where they illustrate the improvements of the present time.

I might be permitted to say, however, that so far as the correct practice of air compressing goes, the subject was well understood as far back as the year 1830, when Thilorier received the medal of the French Academy of Sciences for his method of compressing gases by stages. And about the year 1849 the Baron von Rathen proposed the use of compressed air locomotives, carrying air at 750lb. per square inch; and in order to obtain such high pressures he fully described the process of stage compression *with intermediate cooling*, and pointed out the specific advantages of the cooling. As will be seen later on, the process of stage compression with cooling between the stages, with the application of the process to moderate pressures, has formed the great step in the recent improvements in air compressors.

Stage compression is, of course, an old idea when applied to high pressures, but its application to such moderate pressures as 60lb. and 90lb. per square inch, in order to render possible the use of thorough intermediate cooling, has formed a step almost as important as a new invention.

Modern air compressors may be divided broadly into two classes, viz.:—Class I.: Wet compressors, or those using a water piston. Class II.: Dry compressors, or those using very little or no water in the cylinder.

Class I. may be subdivided into three classes, viz.:—(*a*) Those designed by M. Sommeiller for the Mont Cenis tunnel, and depending upon the use of a natural head of water conducted alternately to chambers, which, by means of suitable valves, can be filled and emptied automatically, as shown in Fig. 1. (*b*) Those which are the direct outcome of *a*, but in which the power of an engine is used to create an artificial head of water by means of plungers working in barrels similar to water pumps. (*c*) Those which are a step still nearer to the dry compressors, and in which the water is only used for cooling purposes and to fill up clearance spaces at the end of the stroke.

Type (*a*) is practically obsolete on account of its slowness of action and consequent large size and cost. It will be understood that it would be almost impossible to stop such a large body of water with sufficient frequency to make quick strokes. The speed of the one used at the Mont Cenis tunnel was about three strokes per minute.

Type (*b*).—In this type the compressing force is got from a steam engine; and in order to retain the apparent advantages of the water piston, the steam engine drives plungers which displace a certain body of water and thus obtain what might be called an ebb and flow of the water in the compressing vessel. The speed of the plungers is about 100ft. per minute. Though not much adopted in England, this is a type of compressor which is widely used on the Continent.

Type (*c*) is what might be called the modern kind of wet compressor, and is a very great improvement over type (*b*), though both are due to the designs of the same engineers—viz., Dubois and François. Of course there are many intermediate stages between (*b*) and (*c*), but time does not permit of a longer pause on this part of the subject. The water used in type (*c*) has a totally different object to that used in (*a*) and (*b*)—viz., it is injected under high pressure during the compression part of the stroke, and is pulverised into fine mist by means of nozzles so as to ultimately mix with the air and absorb the heat due to compression. Only just sufficient to absorb the heat and to make up for loss due to the water carried away with the compressed air is injected. The advantages of (*a*) are: The necessarily slow action of the water columns during compression gives considerable time for the heat of compression to pass through the walls of the vessel, and thus produces a near approach to isothermal compression.

The disadvantages are: Large and costly machinery in proportion to the turn-out.

For all practical purposes air may be taken to be a perfect gas, obeying the usual gaseous laws, and capable of sustaining all practical pressures without condensation into a liquid.

If it is desirable for any purpose to increase the pressure of air from one degree of intensity to another, it can be done in two ways—either by increasing the temperature of the air while the volume is kept constant, or by decreasing the volume while the temperature remains constant. An approximation to the latter process is the one almost universally adopted in air compressors. Suppose, then, that we have an ideal cylinder which is impervious to heat, and is fitted with an air-tight, frictionless piston, which can be made to force the whole of the air out of the cylinder at each stroke—in other words, suppose the piston to work without clearance spaces: If the cylinder is fitted with an indicator and suction and delivery valves, the following actions will occur when the piston is drawn from one end of the stroke to the other:—First, air will be drawn into the suction end of the cylinder until the piston reaches the end of the stroke. With perfect valves the line drawn by the indicator will be that of the low pressure—say atmospheric. The piston now returns, and the suction valves immediately close, and as the piston continues its motion the volume of the space containing the imprisoned air is constantly being reduced, and the pressure consequently increases. This goes on until a point is reached when the pressure inside the cylinder is equal to that above the delivery valve, after which the valve opens and delivery, at practically constant pressure, results until all the air is expelled and the piston is once more where it started from.

Now it is very important to make a clear distinction between the work done in compressing the air and that spent in delivering it into the reservoir. The work of compression is done at the point C on the ideal diagram (Fig. 2); after that point the work is spent in forcing the air out of or delivering it from the cylinder. When the compression commences there is a volume—V_0, say—of air in the cylinder at atmospheric pressure and temperature; and if the temperature could be kept constant during the whole operation, the work done in compressing and delivering the air would be a minimum for that temperature. But as soon as the piston begins to reduce the volume, heat begins to appear. This heat causes the temperature to rise, and consequently the pressure reaches that of the delivery at an earlier part of the stroke than it would if the heat could have been conducted away as fast as it was set free. If no heat whatever escaped into or through the walls of the cylinder, the curve would be called an adiabatic curve; while the curve in the other extreme case, where the whole of the heat passes away as quickly as it is developed, is called an isothermal one. The actual curve obtained in practical compressors lies between these two, but is generally much nearer the adiabatic than the isothermal. As far as the compression portion of the stroke goes, it makes very little difference which curve is followed, for the net work spent in attaining the same final pressure is practically the same in both cases; but it is very important to keep as near the isothermal curve as possible, on account of the effect on the delivery portion of the stroke. This is clearly seen by superposing the two ideal diagrams (Fig. 2). C E is the isothermal curve for a certain volume of air, and F E the adiabatic for the same volume. The areas C I E C and F J E F are practically equal, but the delivery area, F D A H F, for the adiabetic compression, is greater than that for the isothermal compression, C D A G C, by the amount F C G H F, on account of the increased temperature and consequent greater volume of the air. If cases existed where the air could be used at its high temperature, the adiabatic method would be more economical on account of the smaller size of the plant for the same delivery; but it unfortunately happens in nearly all practical schemes for the transmission of power that the air passes through pipes, etc., at the atmospheric temperature, and the heat is almost immediately radiated, and the work represented by the area F C I J F becomes a dead loss. To reduce this loss to its lowest limits has been the object before every designer of air compressors.

Having so far described the ideal diagram, we will now consider the modifications brought about by practical considerations, such as clearance volume, resistance of valves and passages, and insufficient area of delivery.

The diagram, Fig. 3, may be taken as a fair sample from the ordinary compressor, and shows clearly the many defects common to it. Assuming the piston to start from B, we notice that the suction valves do not immediately open, because the air compressed into the clearance space A B of the cylinder by the previous stroke of the piston expands behind the piston until a point C is reached, at which the pressure has become equal to that of the atmosphere. So far, therefore, the stroke is wasted, for no fresh air is admitted. As soon as the piston passes C the suction valves open and air is drawn in, but owing to the resistances of passages, or insufficient area, the atmospheric pressure is not maintained, and a difference of pressure seldom less than 1lb. per sq. in., and frequently much more, is required to keep up the supply as the piston moves. Even a resistance so small as 1lb. per sq. in. makes a very considerable waste of power when continued; and the power is absolutely wasted, for it generally happens that the atmospheric pressure is reached before the piston begins the return stroke, owing to the slowing down of its velocity near the end of the stroke. The compression stroke now commences and heat is rapidly formed, resulting in a raising of the curve up to the adiabatic, or very nearly so. And this in spite of the fact that the cylinder is generally provided with a water jacket, which is frequently supplied with water in such a manner as to prevent any considerable advantage being derived from its use. The cooling water should be delivered into the jacket near the bottom and close to the barrel of the cylinder, so that a natural circulation may result. Very often, however, the cold water is admitted at the top, under the idea that, being cold, it will sink through the warmer water already in the jacket; of course, the latter is far in excess of the former, and so the cold water is quickly heated and does not accomplish the object for which it was admitted. When the pressure reaches the point D, the delivery valve opens, and compression is complete, the remainder of the stroke being taken up in forcing the air into the receiver. By far the greater number of compressors are provided with ordinary pump valves, sometimes with springs above them, and sometimes without; but in either case the lift is always limited to a very small amount on account of the hammering action of the valve in closing with the load upon the top. It frequently happens that even if the valve lifted until the opening round the edge was equal to the area of the pipe, there would not be sufficient space for proper delivery, for no defect is more common than contracted passages and limited areas. In consequence of this resistance, the pressure necessary to force the air out at the velocity with which the piston is moving is much greater than it ought to be, and great waste of power and heating is the result. The writer has inspected diagrams from many kinds of compressors with automatic acting valves, some with ordinary drop valves without springs, some with springs, indiarubber valves closing on grids, metal discs and rings closing on numbers of small holes, flap valves with spring buffers, ball valves, and many others, and has come to the conclusion that if perfection is to be approached it must be by using some mechanical means for opening and closing the valves without shock, or at least for regulating the speed of closing.

Owing to the clearance spaces there is a considerable volume of high-pressure air left in the cylinder at the end of the stroke, and this must be expanded down to atmospheric pressure before the suction valve will open. Of course, it would easily be possible to make the clearance spaces so large that no air whatever would be delivered above a certain pressure—in fact, cases of the kind are known to the writer; but in reasonable cases there is no actual loss of power by clearance spaces (though there is a great loss of volumetric efficiency), for the air expands behind the piston and helps the steam engine in its work.

(To be continued.)

Society of Engineers.

The first ordinary meeting of this society for the year 1893 will be held on Monday, the 6th of February, at the Town Hall, Westminster, when the president for the past year, Mr. J. W. Wilson, jun., will present the premiums awarded for papers read during the year, and the president for the year 1893, Mr. W. A. M. Valon, will deliver his inaugural address.

Shipbuilding Notes.

The Montrose Shipbuilding and Engineering Company, Montrose, have received an order from a Hamburg firm to build a three-masted schooner, 240 tons register, with a carrying capacity of 370 tons.

Messrs. Russell and Co., Greenock, have started to build a couple of spar-decked sailing ships, with a carrying capacity of 3800 tons each, one of them for Messrs. Dennistoun and Co., Glasgow, the other for a Liverpool firm.

Messrs. Cochran and Co., of Birkenhead, have booked an order from Messrs. Lamport and Holt for a number of covered lighters for use at Valparaiso, Talcahuano, and other West Coast ports, in connection with their line of steamers.

On the 20th ult. there was launched from the shipbuilding yard of Messrs. Scott and Co., Bowling, a screw steamer built to the order of Mr. William Robertson, Glasgow. The dimensions of the vessel are:—175ft. by 26ft. 6in. by 13ft. Compound surface condensing engines are being supplied by Messrs. Ross and Duncan, Govan.

The new screw steamer "Clytie" ran her official trial at Skelmorlie on the 21st ult., when a mean speed of 11½ knots was attained on the measured mile, which was considered highly satisfactory by the owners. Her dimensions are 162ft. 3in. by 25ft. 6in. by 12ft. 7in., and she is fitted with compound engines having cylinders 21in. and 42in. diameter by 30in. stroke, by Messrs. Muir and Houston, Glasgow.

Messrs. Fleming and Ferguson, shipbuilders and engineers, Paisley, launched, on the 23rd ult., the powerful twin-screw hopper dredger "St. David," built to the order of H.M. Government, for carrying out extensive deepening operations in the Channel at Portsmouth. She is built with the builders' improved type of stern wheel, and her dimensions are 200ft. by 36ft. by 15ft. 6in. She has a hopper capacity of 600 tons, and is capable of raising 600 tons per hour from a depth of 45ft. The main engines are compound surface condensing, to indicate 800H.P.

Last week, off the mouth of the Tyne, the gunnery and speed trials took place of a new war vessel of the cruiser class, the "Nuevo de Julio," designed and built for the Government of the Argentine Republic by Sir W. G. Armstrong, Mitchell and Co. The principal dimensions of the "Nuevo de Julio" are:—Length, 354ft.; breadth, 44ft.; 26ft. depth of hold; displacement, 3570 tons. During her trial she realised the speed of 22·74 knots as a mean of runs on the measured mile. The indicated horse-power reached 14,500. The engines are by Messrs. Humphrys, Tennant and Co. For armament the "Nuevo de Julio" carries four 6in. quick-firing guns (three of which can fire right ahead and one right astern), eight 4·7in. quick-firing guns, 12 3-pounder Hotchkiss guns, and 12 1-pounder Hotchkiss guns. She is also provided with five tubes for 18in. Whitehead torpedos. During her trials three rounds were fired from each gun. All worked perfectly.

The Swedish armoured double monitor "Thule," which was laid down at Finnboda, Sweden, in the autumn of 1891, and which has just been launched, represents a type of vessel now much in favour with naval powers of the second and third classes. With a very moderate displacement and shallow draught, she has good speed, a heavy armament, and exceedingly good protection. Her displacement is 3100 tons; her length, 260ft. 9in.; her beam, 48ft.; her draught, 16ft. 2in.; her I.H.P., 3150; her coal capacity, 250 tons; and her speed, 16 knots. She is a twin-screw, single-masted, two-funnelled vessel, with an over-all protective deck of 2in. of steel and two turrets, one forward and the other aft. The belt, which is a complete one, has steel armour varying in thickness from 7½in. to 11½in. Armour of the same nature and thickness covers the two turrets, each of which will contain a single 10in. Elswick B.L. gun. Elsewhere there will be mounted four 6in., five Q.F., and six machine guns, and there will be torpedo ejectors.

Advances in Electric Heating.*

SOME three years ago, while engaged in compiling matter for a new catalogue, my attention was attracted to an electric heater which had been used with a certain amount of satisfaction on a few electric roads. It seemed to me at the time that there was a wide and promising field for electric heaters of various kinds, and accordingly I made arrangements with the company manufacturing them to take the general agency for their heater. The patentee of that heater deserves credit for what he accomplished, yet it is not surprising that faults were discovered in both their construction and form. My impression at that time was that while improvements would be made, and new heaters invented and patented, yet that even in an imperfect heater large sales could be made, as the advantages of this method of heating would more than counterbalance the objections raised. Advances in the science of electricity are so rapid that it is little wonder that while a number of those who are foremost in the electrical business ridiculed my idea, yet some half-dozen of these very people are now engaged in exploiting electric heating.

The last three years' experience in this business has convinced me more than ever of the immense and successful future for electric heating, cooking, etc. Being anxious to furnish at all times the best obtainable, I have taken advantage of the latest improvements, and we are now offering one particular make of heater, but we are nevertheless pleased to see others interesting the public in this modern, convenient, and altogether desirable method of heating. The field is attractive and enlarging daily. The heater was originally designed to meet the demand for some means of heating less objectionable than the coal stove in street cars. The public is disposed to blame managers of street roads for not heating cars, yet no one is more anxious to please the riding public and make them comfortable than these managers. The objections to the use of the coal stove are so great that it is no wonder that it is a question whether its use is an advantage great enough to warrant its employment.

In the first place, the stove takes, to say the least, the room of one passenger—sometimes two. The gas, the ashes, and the smoke are ruinous to paint, decorations, and cushions of the car, as well as disagreeable and unhealthful for the passengers. It requires constant attention, and is generally a source of danger to passengers, the car, and the car barn. Burning of car barns and cars, caused by coal stoves in cars, is of frequent occurrence. A reliable electric heater does away entirely with every one of these dangers. Four of these heaters being placed under the seats, take no room whatever needed for seating passengers. On account of the distribution of the heaters, the car is heated perfectly and in all parts. It is not necessary to even look at the heaters during the day, and as long as the dynamo at the station is in operation, heat in sufficient quantity to warm the car is assured.

In former seasons objections have been made to electric heaters because of the frequency of the wires burning. This has been entirely obviated in the latest improved heater, while the heat is stored in such a manner that, if desired, no current need be used during the evening rush, the car being kept warm for at least an hour or more after the current has been turned off. In most cases the cost of current consumed is not more than that for coal burned in a stove, while the other expenses connected with the use of coal stoves being done away with entirely, warrants the statement that heating by electricity is not only the most agreeable and convenient, but also the most economical method of heating electric cars.

The fact that something like 200 electric roads, in the United States and Canada, are now heating their cars, wholly or in part, in this manner, seems to prove this assertion. Soon after introducing electric heaters for street cars, a demand arose for other heaters for use in private houses, stores, offices, etc., as well as for cooking purposes. An electric stove brought out by us this season has already had a large sale, and the advantages of having a warm room in a few minutes' time by simply touching a button, ensures for this device a constantly increasing sale.

Hot-water heaters for use in drug stores, bar-rooms, barbers' shops, as well as for making tea and coffee in restaurants and private houses, are also being furnished, while bakeries have been fitted with ovens, and baking by electricity is pronounced, not only a success, but as being a better method, giving better results than the old method. Electric heating for private houses is undoubtedly, in many cases, somewhat expensive, but on account of the great advantages we may certainly expect that another season will see a great number of houses using electricity, not only for lighting, but also for heating and cooking.

* By W. R. Mason, in "Electrical Industries."

Notices of New Books.

THE WATER METER: ITS DIFFICULTIES, TYPES, AND APPLICATIONS. By WALTER G. KENT. London: E. and F. N. Spon.

COMPARATIVELY little reliable information on the theory and practice of water measurement by meter is available, and for this, if for no other reason, Mr. Kent's little treatise would be a welcome addition to water-engineering literature. But Mr. Kent is able to bring to bear upon the subject a long, intimate, and practical experience with all the principal forms of water meters, and consequently his remarks and comments upon this important matter deserve the careful consideration of water engineers and others interested in the subject. The author commences with a preliminary inquiry into the requisites of a good water meter, and pertinently contrasts the ideal meter with those generally met with. In the second chapter he gives a brief account of water practice at home and abroad, while in the third division of the book he formulates the purposes for which meters are required, and describes at length those instruments best adapted for various duties. In Chapter IV. the prices and value of water meters are discussed. Chapter V. is on the delivering capacity of meters, while Chapter VI. contains many useful hints on the selection, fixing, and maintenance of meters. Meter rents and charges are dealt with in the following section, while in Chapter VIII. the question as to who should own the meter—the supplier or the consumer—is considered. The concluding chapter discusses the economics of water supply considered in relation to the method of payment. As will be seen, Mr. Kent has treated the subject from almost every conceivable standpoint; moreover he has given some interesting particulars of his method of testing meters, tables of various kinds, etc., which cannot fail to be of very great service to water engineers generally, to whose notice we have pleasure in cordially commending the work.

METAL COLOURING AND BRONZING. By ARTHUR H. HIORNS. London: Macmillan and Co.

MR. HIORNS, who is the author of several works on metallurgy, and the Principal of the Metallurgy and Engineering Department of the Birmingham Municipal School, has in the work under notice turned his attention to the somewhat neglected subject of metal bronzing, with excellent results. As explained in the preface, the work is not a haphazard compilation of recipes for colouring and bronzing metals, but is the record of investigation carried out by means of many hundreds of experiments extending over a period of eighteen months; and as the author has taken nothing for granted, and has given a faithful record of the results he himself obtained, it is plain that the work is calculated to be of far greater practical service than the usual kind of matter presented in works of a more pretentious description. The work is divided into three main divisions; the first dealing with chemical metal colouring, the second with electro-chemical metal colouring, and the third with mechanical metal colouring. There are also two useful introductory chapters dealing with the chemical effect of the atmosphere, chemical principles and changes, and also with cleaning, dipping, polishing, etc., of metals. We can recommend this work with pleasure as an eminently practical treatise on the subject.

THE PRESENT POSITION OF ROLLER FLOUR MILLING. By HENRY SIMON, Manchester. Published by the Author.

MR. SIMON, who is well known in connection with roller flour milling machinery, has prepared a very interesting and instructive work on the subject. It is divided into five sections:—(1) The present position of roller flour milling, with special reference to the Simon system; (2) mill buildings, grain silos, motive power, insurance, and fire prevention; (3) wheat-cleaning machinery; (4) roller milling machinery; and (5) accessory machinery. A large number of illustrations are given of flour mills on the Simon system erected in various parts of the world, and a full list, including illustrations and prices of the various machines and appliances supplied by Mr. Simon, is appended. The printing and general get-up of the work is of a very high-class character.

PRACTICAL ELECTRIC-LIGHT FITTING. By F. C. ALLSOP. London: Whittaker and Co.

MR. ALLSOP, who is the author of several well-known works on electrical-instrument fitting, and the member of a firm of manufacturing electricians, is eminently qualified to prepare a work of the kind under notice. Too many so-called "practical" works are written by those whose acquaintance with the particular art or handicraft is of a very doubtful kind. A work like Mr. Allsop's is therefore of considerable value to all electric-light fitters and working electricians generally. In it, the wiring and fitting up of buildings deriving current from central-station mains is fully dealt with, while the laying down of private installations is also considered at length. The latest edition of the Phœnix Fire Office rules is included in this eminently practical and useful treatise.

WE have also received:—"How to Manage a Dynamo," by S. R. Bottone (Whittaker and Co.), a useful little handbook for ship engineers, electric-light engineers, and electro-platers. The number of valuable hints given will be much appreciated by all dynamo attendants.—"Weights, Measures, Moneys and Interest Tables," published by L. Bartlett-Amati, of the National Bank of Italy, Rome (3s. 6d.), is a capital collection of useful tables of conversion of English and foreign weights and measures, moneys and interest tables, which will be found of very great service to engineers, merchants, manufacturers and exporters.—Blackie's "Guides to the Science Examinations" ("Theoretical Mechanics," by R. H. Pinkerton; and "Applied Mechanics," by D. A. Low; 6d. each). These are two little handbooks for students preparing for the Science and Art Department examinations in mechanics, containing useful hints and examination questions with answers. We recommend intending candidates for these examinations to procure copies of these little works.—Mr. Thomas Jones, 27, Barton-street, Moss Side, Manchester, has published a set of cardboard models which will be found of great assistance to teachers and students in practical geometry classes. The first series (1s. 3d.) consist of six examples of the representation of lines and planes, and are in every way calculated to greatly aid the elementary student in mastering the principles of descriptive geometry.—Cassell's "New Technical Educator" (Cassell and Co. Limited; 6d. monthly) contains several interesting and instructive serials. Among the subjects treated are steel and iron, cotton spinning, cutting tools, photography, watch and clock making, woollen and worsted spinning, practical mechanics, electrical engineering, the steam engine, etc. The work is well printed and illustrated, and certainly deserves to be commended to those who seek to acquire technical education by self-instruction.—The same enterprising firm of publishers is issuing, in 6d. monthly parts, "Electricity in the Service of Man," a translation from the German by Mr. R. Wormell, the present edition being revised and enlarged by Mr. R. M. Walmsley. When complete it will form a very comprehensive and practical treatise on the generation and application of electricity to every-day requirements.—Mr. Cuthbert S. Metcalfe, Sunderland, has prepared two sets of examples (4s. each) of "Machine Construction" for advanced classes, which have several points of merit. The drawings are, with the exception of two, uncoloured, but are section-lined and fully dimensioned. Moreover, many useful tables, rules, and data are given on the several plates, together with instructions for colouring, etc. One of the divisions of the work contains a series of miscellaneous examples, while the other is chiefly devoted to a number of drawings of a high-pressure marine engine. Great care and thoroughness is manifested in the preparation of these two books, and students in machine design could wish for no better series of practical examples. We may add that we have had the opportunity of inspecting some of the work of Mr. Metcalfe's students, the character of which certainly reflects great credit upon his system of tuition.—Messrs. Sampson, Low and Co. are now issuing "The Illustrated World's Fair" (1s. monthly), an elegant American publication devoted to the Chicago Exhibition and scientific literature. The December issue contains views of the Machinery Hall and a capital interior view of the Electricity Building, besides several other illustrations and particulars as to the progress of construction. We commend this work to the notice of intending visitors, as it will probably be the most complete record of the exposition published.—From the London County Council we have received a voluminous report to the Special Committee on Technical Education, by Mr. H. L. Smith, M.A., secretary of the committee. The special object of the inquiry was to investigate the wants of London with regard to technical education, the existing provision to meet such wants, and the mode in which the County Council could best promote technical education in the metropolis. The volume contains an immense amount of information, tables, maps, etc., and should certainly be in the hands of all who are specially interested in this important matter.—The "Shipping World" Year-book for 1893 is again to hand, containing many important alterations, and with 130pp. additional matter. To shipowners, brokers, and masters, as well as to engineers and merchants, the work must be well-nigh indispensable.

Trade Notes.

The Yorkshire Railway Wagon Company recommend a dividend at the rate of 6½ per cent. per annum.

Steps are being taken to construct a new harbour at Ravenscraig, Kirkcaldy. The cost is set down at £300,000.

Messrs. James M'Kenzie and Co., Phœnix Tube Works, Dalmarnock-road, Glasgow, are carrying out important extensions at their works.

Messrs. A. Macleod and Co., Glasgow, have received the order to fit up an electric plant at the works of Messrs. Singer and Co., Dundee.

The Russian Government have rejected the request of the railway companies to be allowed to give orders for railway material abroad.

Messrs. Tangyes Limited, of Cornwall Works, Birmingham, sent out 500 gas engines during the past year. Their power varied from ½ to 100H P.

The Normanby Iron Works Company have damped down one of their furnaces working on hematite, on account of the unsatisfactory state of trade.

Messrs. J. H. Wilson and Co., Sandhills, Liverpool, have contracted to supply two locomotive steam cranes and two steam diggers to the Belfast Harbour Commissioners.

The contract for the construction of the Bowling and Dumbarton section of the Lanarkshire and Dumbartonshire Railway has been secured by Messrs. Robert M'Alpine and Son, Glasgow.

Messrs. J. and R. Houston, engineers, Greenock, have sent on to Glasgow, for transhipment on board the steamer "Gulf of Venice" for conveyance to Australia, 350 tons of sugar-refining plant.

Messrs. George Cradock and Co., of Wakefield, who supplied the wire rope for the recently-completed Brixton-hill cable tramway, have received an order for a spare cable 30,000ft. long and 3⅝in. in circumference.

The Arrol's Bridge and Roofing Company, of which Mr. Arrol is the managing director, has taken over the works of Messrs. Arrol Bros., Germiston, which have been closed for nearly a year. Operations were resumed on the 23rd ult.

Messrs. Rose, Downs and Thompson, Hull, have received an order for dredging machinery, of their patent "Kingston" type, for a harbour board in New Zealand. The dredgers, which are of the grab-bucket type, will be fixed on a hopper barge of 250 tons capacity, with a sand pumping apparatus.

The annual report of the Maxim-Nordenfelt Guns and Ammunition Company states that on account of the diminution in the orders received, and in consequence of the factories having been barely half employed, a loss of £22,912 has been incurred in the operations of the year, thus reducing the amount at the credit of undivided profits to £7499. The chief cause of this loss arises from the serious decrease in orders from the Government.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 391, Strand, London, or New Bridge-street, Manchester.

Wheel cutter in metal only. Every description of gearing. R. CHIDLAW, 43, City-road, Manchester.

Having regard to the enormous circulation of THE MECHANICAL WORLD, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if MECHANICAL WORLD readers will kindly bear this in mind as occasion arises.

The Design and Construction of Stationary Engines.—XLVII.

An American writer on counterbalancing states that if a weight is placed opposite the crank, equal to the crank and pin + (the reciprocating mass multiplied by the initial accelerating force, and divided by the weight of the non-reciprocating mass—*i.e.*, bedplate, cylinder, etc.), good running will result.

In the case of a Porter-Allen engine, the counterweight was made 135lb., the weight of the reciprocating parts being as follows:—Piston, with rod, 83lb.; crosshead, 42lb.; connecting rod, 109lb.; total, 234lb. The

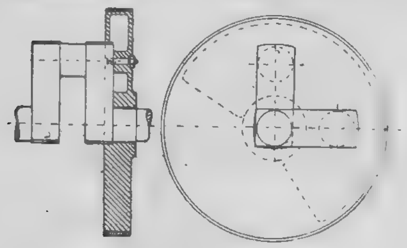


Fig. 197.

counterweight was here 58 per cent. of the total weight, as at the crankpin, thus leaving 42 per cent. of the reciprocating parts unbalanced. Although there was an excess of weight for vertical balance, the working of the engine was satisfactory.

Vertical engines require to be more carefully balanced than horizontal ones. To assist this they are generally given more lead at the bottom stroke than at the top, and the exhaust port is closed sooner to increase the cushioning on the bottom side.

As a rule, also, vertical engines are run at higher rotative speeds than horizontal engines, hence the necessity

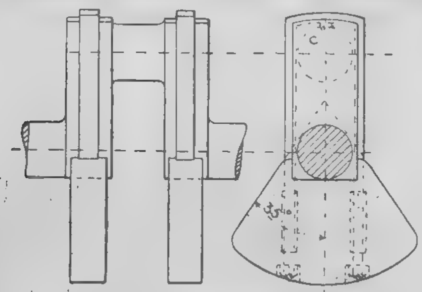


Fig. 198.

for more care in balancing them. The method of forming the balance on the cranks depends on their form. The most convenient crank to balance, and which is mostly used for horizontal engines, is the disc crank, as shown in Fig. 190. By filling up the hollow opposite the crank with metal, the necessary weight is obtained for the required balance. This weight, if made to extend nearly one-third of the circumference, will be found to afford sufficient weight for ordinary cases. Another form of balanced crank is shown in Fig. 191, which consists of a fan-tail extension of the crank itself.

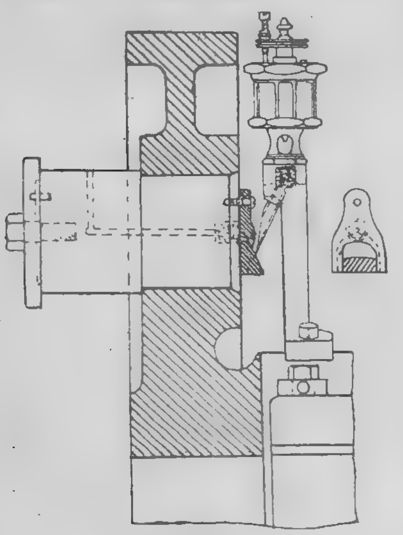


Fig. 199.

Cranked shafts are balanced in various ways. Fig. 197 shows one method, common in American practice, which is used for a double-throw crank. Fig. 198 shows a form of balance adopted in torpedo-boat engines and vertical high-speed engines for driving dynamos and such like machinery. The balance consists of a wedge-shaped cast-iron weight placed opposite to the crankpin, secured by flat straps and nuts let into the cast iron. The straps are let into the webs, which are planed out to suit, thus preventing the straps from shifting sideways. Sometimes the end of the strap is provided with a round pin, as at C, riveted on and let into end of crank. The recesses for the nuts after they are screwed up are generally filled up with white metal, preventing the nuts from coming loose. This is a good way to attach the balance weight, but it is expensive.

Crankpin Oilers.—A good system of oiling the crankpin is of great consequence in reducing friction and securing good running of the engine. The most usual

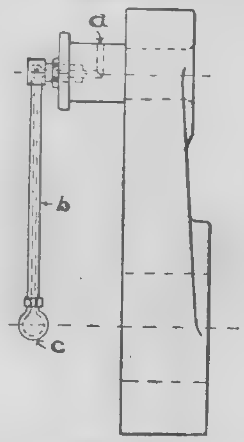


Fig. 200.

way of lubricating the pin is to screw an oil or grease cup into the connecting-rod end, the oil being drawn over into the tube by the capillary attraction of a wick, one end being inserted in the tube and the other in the oil. Other devices depend for their action on the movement of a wire caused by the oscillation of the rod end, allowing a drop of oil to pass at each stroke. In other cases the oil cup is suspended over the path of the rod, the supply being regulated by screwing the cover up or down, which actuates a plug,

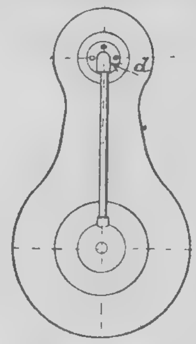


Fig. 201.

allowing more or less oil to flow, the cup being so arranged that the drops are visible as they fall. The oil is delivered on to a strip of lamp wick, which is brought low enough so that a lip or blade on the oil cup on the rod end wipes a drop of oil off at each revolution. This method is employed in the Armington and Sims high-speed engine, and is very efficient for continuous runs.

In other engines of this class the oil-feed is mechanical in its action without the use

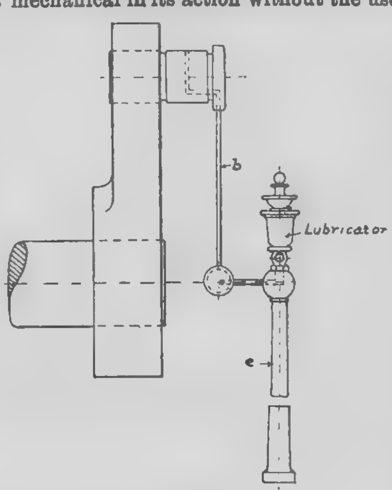


Fig. 202.

of a wick. The oil cups proper are fixed on stationary supports and the oil therefrom is transferred to a wiper on the cup fixed in the connecting-rod end. This wiper is a curved blade, the edge of which passes close to the point of the fixed lubricator, and takes off the drop of oil hanging thereon, passing it on to the moving surfaces.

Fig. 199 shows the method of lubricating on this system the crankpin of the Porter-Allen engine. It will be seen from the figure that the wiper has a broad inclined surface to receive the oil, which, through the centrifugal force, flows radially into the passage drilled through the back of the crankpin, and by which it is led to the surface of the pin.

A very simple and effective arrangement for automatically lubricating the crankpin of mill engines is that known as the centrifugal crankpin oiler. Fig. 200 shows one arrangement of this form of oiler. It consists of a tube *b*, the inner end of which is terminated by a brass internally-chambered cup or ring *c*, which is concentric with the shaft, whilst its outer edge is rigidly secured to the crankpin in such a manner that its internal passage is in communication

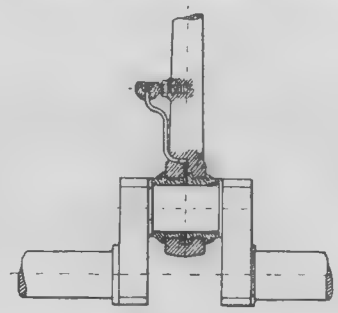


Fig. 203.

with a passage in the pin, emerging at *a*, as shown by the dotted lines, so that oil introduced at *c* promptly issues at *a* and effectually lubricates the brasses. A feeder-cup is usually fixed on a stand or support in front of the crank, as in Fig. 202, from which the supply of oil can be regulated as required while the engine is running.

Fig. 201 shows a similar arrangement, the flange *d* being secured to the crankpin by three set screws, as shown. Sometimes the outer flange or collar of the crankpin is made separate from the pin, and the set screws for the oiler serve to fasten both flange and oiler to the crankpin.

Fig. 202 shows a Continental arrangement of the oiler, the tube *b* being screwed into the outer collar of crankpin, semi-circular grooves being cut into the pin at the outer edges, to retain the oil; but this appears to be a questionable device to adopt for a crankpin.

Fig. 203 shows one way of lubricating the pin of a cranked shaft of a small vertical engine. The lubricator is screwed into the connecting rod clear of the sweep of the crank, and a small pipe led down into the rod end, as shown, conveying the oil or grease to the journal. A centrifugal lubricator for cranks of another description has been much used in marine-engine practice, consisting of a brass casing encircling the shaft, made in two parts and bolted together. The upper part is arranged to fit into a passage drilled through the crankpin, and running from this central hole out to the surface of the crankpin are smaller ones, through which the oil is conveyed to the crank brasses. The lubricator is open all round the shaft, there being an annular space between the shaft and the outer turned-down lip of the lubricator, into which the oil and water pipes lead. This arrangement is neat and occupies but little room axially.

(*To be continued.*)

It is stated that a systematic test of the behaviour of electric safety lamps in fiery mines is to be made shortly at a well-known colliery in South Staffordshire.

Engineering Students' Club, Newcastle-on-Tyne.

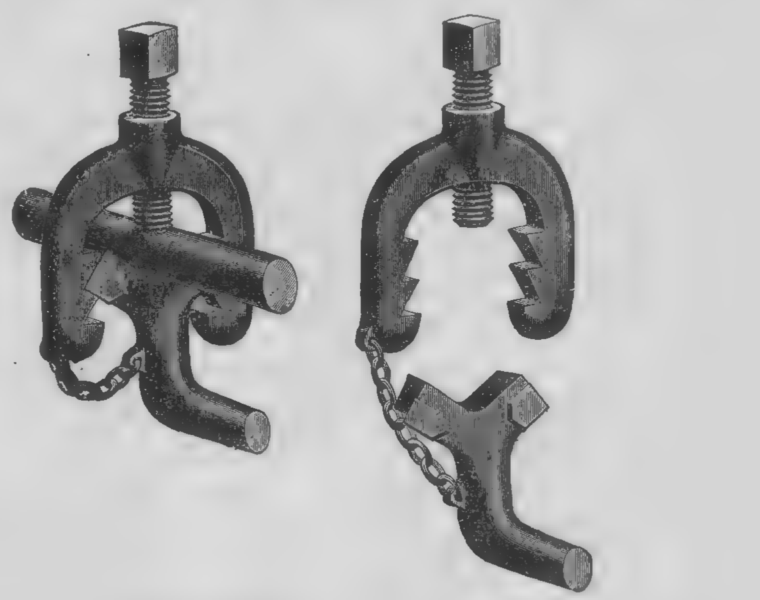
A meeting of the above club was held at the Durham College of Science, on Wednesday, January 25, when a paper by Mr. Geo. Swan, on "The Electric Transmission of Power," was read. Mr. J. E. Gurney was in the chair.

The author, after comparing electric and hydraulic transmission of power, described the relative qualifications of various dynamos used in the transmission of electromotive force. A detailed account of an electro-pumping plant for North Seaton Colliery, erected by Messrs. Ernest Scott and Mountain, Newcastle, was also given by the lecturer. A discussion, in which several of the members present took part, ensued.

A vote of thanks to the author of the paper, and to the chair, terminated the proceedings.

The "Indispensable" Lathe Dog.

Turners and tool makers generally will scarcely need reminding of the inconvenience and loss of time experienced in using the old style of lathe dog or carrier, chiefly but not wholly from the fact that the old style of dog must be placed upon the work before the latter is mounted between the centres. The lathe dog shown herewith overcomes this objection, as it can be readily attached to the work after it is placed in the lathe, while it can be used equally as well between collars as upon plain or straight work. The makers claim that with one set of three of these dogs it is possible to do the work for which ten or twelve of the old style of dog would be required, and that at about one-half the cost. The dogs are strongly made, being drop-forged from bar steel; the boss is of such size that when the thread becomes worn it can be re-tapped and a larger screw used. The set screws are of hardened steel. Further particulars, prices, etc., of these useful appliances may be had from Messrs. Charles Churchill and Co. Limited, 21, Cross-street, Finsbury, London, E.C.



The "Indispensable" Lathe Dog.

Wrought Iron.

The first of a course of six popular lectures, intended for those engaged in the manufacture or use of wrought iron, was given on January 26, in the chemistry theatre of Mason College, Birmingham, by Mr. T. Turner, the lecturer on metallurgy. The lecturer said that it was important at the outset of such a course to understand that the differences in the properties of various kinds of iron and steel did not depend on any differences in the iron itself, which formed the largest proportion of the materials, but in the presence or absence of relatively small quantities of other substances, such as carbon, silicon, and so forth, which, when present in the metal in various proportions, so profoundly alters the physical properties that for practical purposes cast iron, wrought iron, and steel were not three varieties of a single metal, but were themselves three distinct metals. Wrought iron contains the smallest amount of carbon; and this fact was demonstrated to the audience by dissolving different varieties of metal in a solvent and exhibiting the

amount of carbonaceous residue by means of the lantern and screen. Iron ores, or the materials from which iron is extracted, seldom exhibit any sign of their richness in metal which would be recognised by the uninitiated, but are red, brown, or grey earthy substances, which, in order to be valuable, must be rich, plentiful, and pure. Unfortunately the ores in this immediate neighbourhood are becoming more and more scarce year by year, so that the probability of any large increase in the production of pig iron is small. Wrought iron was originally produced by the "direct" process in a single operation from the ore, and such methods are still followed in India, Africa, and other parts of the world where the cost of transit handicaps imported materials. Probably the oldest piece of iron now known is a fragment found in the Great Pyramid, and now preserved in the British Museum; this is believed to be at least 4000 years old, and to be of as quite as early a period as the oldest bronze known. The direct process has been revived in a number of modified forms during the last half-century, and great hopes were at one time entertained of the method introduced by Chermot and by Sir W. Siemens, but both of these have now been entirely abandoned. Two modern processes are now in actual use, the Husgafvel furnace in Russia, and a direct reduction process, followed at Pittsburg; but both, though stated to be profitable, are only conducted on a comparatively small scale. The old bloomary still survives for this purpose in America in outlying districts, and some 300,000 tons of iron are annually produced from the ore in small charcoal hearths. But in this country the indirect method of manufacture from pig iron is now universally followed where wrought iron is produced. When the speaker last lectured on this subject five years ago, the quantity of wrought iron made in this country was greater than the amount of steel produced by either of the leading processes. But in the interval in 1890, Bessemer steel took the leading place, and seems destined to maintain this, though there is every reason to anticipate an honourable and healthy old age for the older process. The depression in recent years has, on the whole, not affected the iron trade so severely as the steel industry in Cumberland and elsewhere, and with a better knowledge of the theory of puddling, with greater economy of fuel, and with improved machinery in many of our local works, there is every probability of the iron trade surviving, though it will probably relatively decline when trade once again revives. The lecture-table was covered with a collection of iron ores from all parts of the world, and the specimens were examined with interest by those connected with the iron trade.

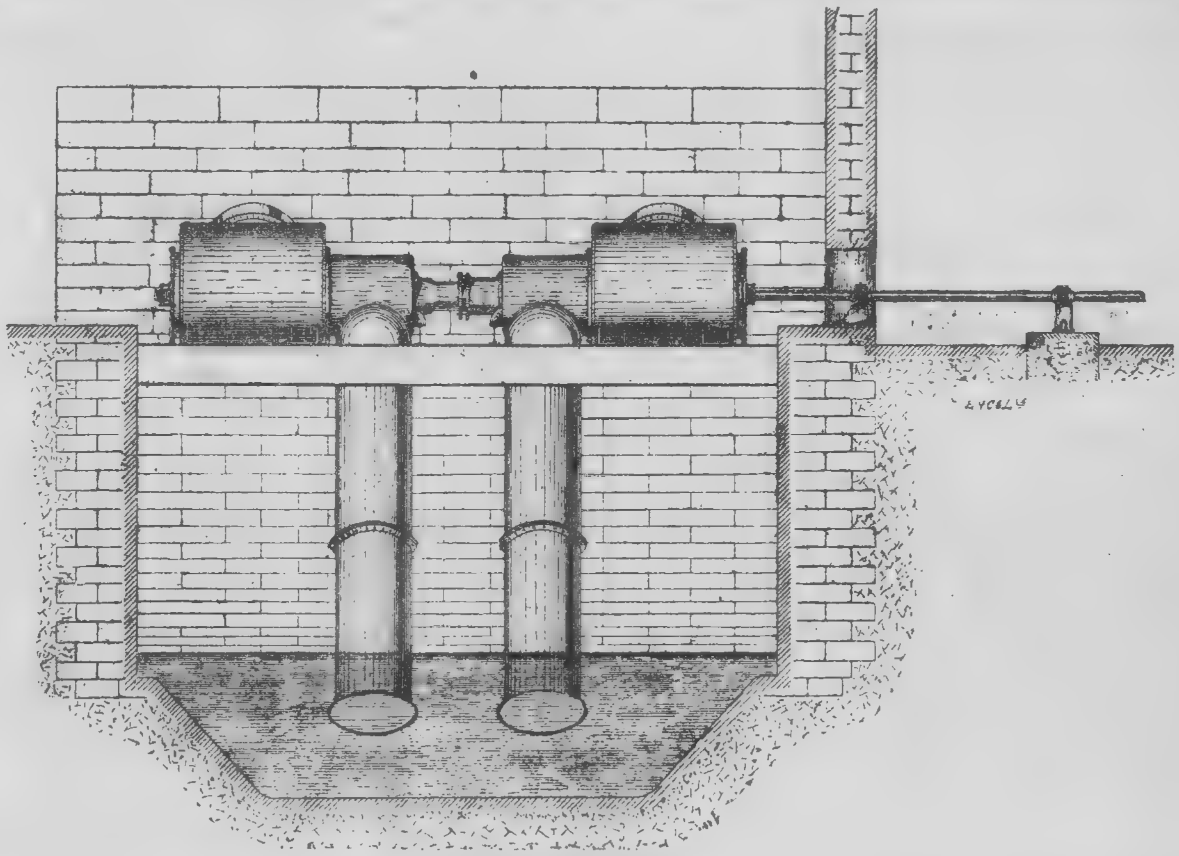
MESSRS. CHARLES CAMMELL AND Co., of Sheffield, have removed another branch of their industry—that of fishplates—to Workington.

200H.P. "Achilles" Turbines.

THE accompanying illustrations represent a pair of 24in. horizontal "Achilles" turbines (McCormick's patent), recently erected at Messrs. Lancaster, Ferguson and Co.'s paper mills, Denton, Manchester, by the European representative, Mr. John Macdonald, 146, West Regent-street, Glasgow.

The turbine nearest the mill was started some time ago, and has been running very satisfactorily since, doing the work it was intended for at about half-gate. The power developed from this single turbine, on a 21ft. fall of water, is upwards of 100H.P.

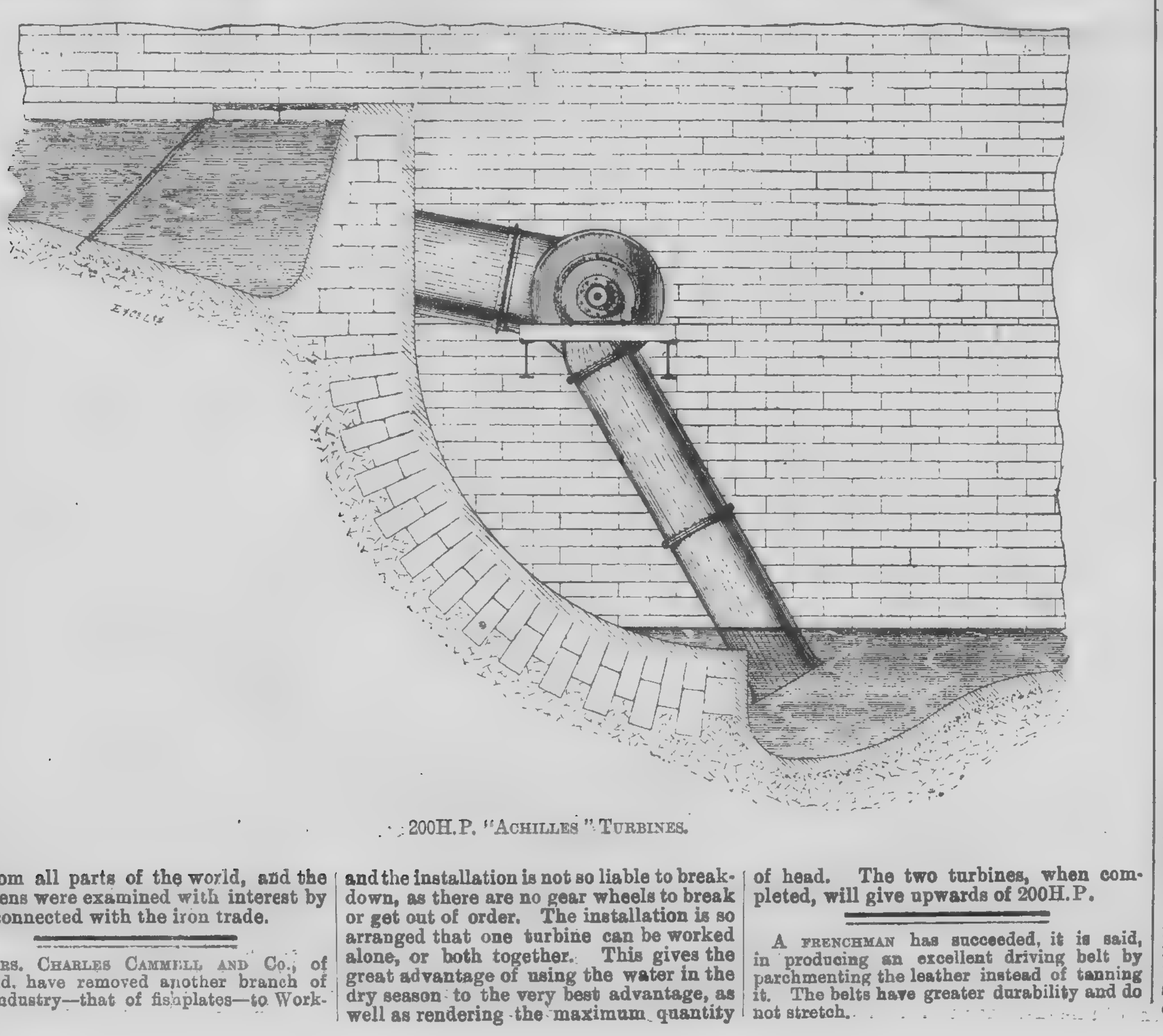
This power, we understand, is considerably in excess of that given by the old breast wheel, which used double the quantity of water available.



200H P. "ACHILLES" TURBINES.

The pair, as shown, are connected direct to the driving shaft of the mill, a feature, we believe, new in paper-mill driving in this country. This arrangement has many advantages over the ordinary vertical setting, as, owing to the direct driving, the friction of gearing, etc., is obviated. It also works without noise, and has a higher duty. Moreover, in many cases the first cost is less; the up-keep is always less, and the installation is not so liable to breakdown, as there are no gear wheels to break or get out of order. The installation is so arranged that one turbine can be worked alone, or both together. This gives the great advantage of using the water in the dry season to the very best advantage, as well as rendering the maximum quantity of water required to give the above power, and which would never, at any time, work in tail water.

The comparison in size between the two wheels is rather interesting—the old wheel being 28ft. in diameter and 24ft. wide, and weighing upwards of 60 tons; while the turbine is only 24in. in diameter, weighs only 25cwt., and will work though drowned in tail water, so long as there is a difference of head. The two turbines, when completed, will give upwards of 200H.P.



200H.P. "ACHILLES" TURBINES.

A FRENCHMAN has succeeded, it is said, in producing an excellent driving belt by parchmenting the leather instead of tanning it. The belts have greater durability and do not stretch.

Engineering Pattern-making.

BY A FOREMAN.

XXVIII.

DURING the last few years several works on machine construction have been written, and in most of these toothed gearing has formed a portion of the text, but as yet none of them have taken the subject from a constructive point of view, beyond giving formulæ for the proportions of the wheel or calculations to determine the power at different velocities. What is now required is the several details for the making and moulding of gearing, the construction of entire patterns or the blocks as used on the wheel-moulding machine, and a description of the latter, so that if the particulars and instructions, together with the diagrams, be carefully perused, they will enable the apprentice or student to clearly understand, both practically and theoretically, how to make or mould any of the several forms of spur, bevel, mortise, helical, and worm wheels, representing real workshop practice.

Such information will not only be helpful to the beginner, but also to those who have not had the opportunity of acquiring a thorough knowledge of the subject by not having been brought in contact with this particular class of work.

As an introduction, we shall define the several kinds of gearing above-mentioned, so that they may be readily identified when met with in the workshop or referred to in the text or diagrams of the following articles.

Spur gearing comprises toothed wheels, the axes of which are parallel to each other. Smaller diameters of spur wheels having a less number of teeth are called pinions, and are generally used as drivers to larger wheels, or in connection with a rack to change circular into rectilinear motion, as in the case of a planing machine table or in raising or lowering any part of a machine in which the pinion is inserted and the teeth of which engage with a rack fastened to another part.

Bevel wheels are used when the shafts or axes form angles with each other and the diameters have a certain ratio. Where the wheel centres or axes are not in the same plane they are known as skew bevels, to which reference will be made later. All bevel wheels are frustrums of cones with teeth set at equal distances on their surfaces, the pitch lines on the back side representing the bases of the cones; the apices meeting where the centre lines intersect. When two wheels of the same diameter are fixed at right angles they are called mitres, as the angle formed by lines drawn from their pitch diameters to the point where the centre lines meet would be one of 90°.

When the smaller wheel contains a number of teeth which is a measure of the number contained in the larger wheel, it is usual to introduce an extra tooth in the smaller one; this is added for the purpose of obviating the contact of the same teeth

at every few revolutions, as a slight irregularity in one of them would always affect the same teeth in the other. For instance, a pair of wheels containing 30 teeth and 90 teeth respectively would engage the same teeth at every third revolution; but if an additional tooth be inserted in the smaller one so that it contains 31 teeth, then in the first revolution No. 1 will work with 1, 32, and 63, in the next revolution with 4, 35, and 66, and will have to make 31 revolutions before it again meets No. 1 on the large wheel. This arrangement destroys the precise velocity ratio, but in heavy gearing the slight irregularities which occur in *cast* wheels, and which produce an unequal wearing, are reduced by this method to the least possible amount.

Mortise wheels are composite in their construction, and consist of cast-iron centre, arms and rim, with wooden teeth inserted in mortises or slots cast through the rim, the object of using timber for the teeth being to reduce the noise consequent upon the contact of metal with metal, especially when running at a high speed. Though perhaps not so strong as metal teeth, they are usually strengthened by being made thicker to the extent of completely filling the spaces between the metal teeth in the companion wheel, and in cases where practicable they are run together for a short time before being fixed in their actual working position.

Mortise wheels also possess a slight advantage where sudden starting is necessary or unavoidable, the elasticity of the timber assisting to prevent the breaking of the teeth, and should this happen the teeth are more easily replaced. This system is applicable to both spur and bevel gearing, and where one wheel only is "cogged" or is a mortise wheel it is usually the larger one that is selected as having the less amount of wear and tear on the teeth.

Helical wheels have their teeth set in an oblique direction, and when correctly formed represent portions of helices or threads, wound round a cylinder, such cylinder being the diameter of the wheel at the bottom of the teeth. The curve of the tooth on each side is not so apparent in the larger wheels, as the angle of the teeth—viz., 55°, which has been found the best from actual practice—almost resolves itself into a straight line, even when the teeth are pared by hand; when cut on the ordinary wheel-cutting machine a straight line is inevitable.

Small helical wheels can be cut in either iron or brass, by planing the spaces out on a planing machine, to which is attached an arrangement of gearing for giving the requisite circular motion to a shaft or mandrel, held between centres or in bearings, and on which the metal blanks are fixed and secured by a nut on the screwed end of the mandrel. This operation is only applicable to the single helical teeth and light wheels mostly used in machine work where smoothness of working is a desideratum.

Double helical—or, as they are more commonly called, "herring-bone" wheels—are in demand where strength and smoothness of working are essential, modern tool work being often geared in this way, which, when properly set, is almost noiseless, and possesses many advantages over the ordinary wheels with right-angled teeth. This particular form of gearing consists of what may be called two wheels, a right and left hand single helical, cast together, the single helical being an improvement on the "step" gearing invented by Dr. Hooke, the object of which was to give a greater working surface, but which has now fallen into disuse, partly through the difficulty of moulding and the extra work in the preparation of a pattern of moderate width.

(*To be continued.*)

The Manchester Association of Engineering Students.

THE monthly meeting of this society took place on Saturday, the 28th ult., at the Central Schools, Deansgate, Manchester. Papers were read by Mr. E. Brown and Mr. A. Laidlaw on "Wood-working Machinery," the first more particularly in reference to lumber-sawing machines after the American method. A large number of diagrams were shown illustrating the various machines used, including the steam niggers, band-saw carriage with steam feed, off-set arrangement for the carriage, and several types of band-saw mills. Several interesting specimens of steel (Swedish) were exhibited as illustrating the various forms of blades used, and showing the effect of the tension obtained. Explanations were given of the methods of brazing the saws, while samples of badly and well-brazed joints were shown. The second paper referred to the standard types of machines met with in the pattern and joiners' shops. Diagrams were shown and explanations given of the construction of the wood-planing, panel-planing, mortising and tenoning machines, dimension and band-saws, cutter grinding and saw setting devices. Several samples of work produced on these machines were exhibited.

A Newspaper Libel Case.

MR. EMMOTT SUES "THE STAR."

THE hearing of this case—an action brought by Mr. W. T. Emmott, of THE MECHANICAL WORLD and other papers, against "The Star" Newspaper Company—was fixed for Wednesday morning, the 25th ult., before Baron Pollock, in Queen's Bench Court II. Mr. A. Cock, Q.C., and Mr. Cluer (instructed by Messrs. Stollard and Swan) appeared for the plaintiff, and Mr. Reid, Q.C., and Mr. Danckwerts were for the defendants. Upon the case being called on, Mr. Cock said he was very glad to be able to inform his Lordship, now that the parties had come together, that that had happened which he hoped might happen, and if his Lordship would permit him he would make a few observations about the case. He had spoken to his learned friend, Mr. Reid, and he thought the arrangement which had been come to was one which would be eminently satisfactory to all parties concerned in the litigation. The action was one brought by Mr. Emmott, a journalist, carrying on an extensive business in Manchester. The defendants published an article on the formation into a joint-stock company of Mr. Emmott's business, consisting of well-known and largely-circulating journals. Mr. Emmott, in promoting that company, proposed that a third of the capital should be offered to persons interested in the trades in connection with which his technical journals circulated, and he himself retained £40,000 out of the £60,000 capital. "The Star" newspaper published on November 9 an article which Mr. Emmott considered reflected upon his action with regard to the promotion of the company, and Mr. Emmott felt bound to bring the present action in order to completely vindicate his position. Upon the article appearing, Mr. Emmott did what he (Mr. Cock) was sure his Lordship would think was a right and proper thing to do: he immediately gave directions that all money subscribed for shares should at once be banked under a separate account until after the trial of any action, and he employed a firm of independent accountants to go into the accounts of his business. Since the date of the article a year had elapsed, so that he was able to say exactly what the result of the trading with regard to those newspapers had been during the 12 months, without touching the capital which had been offered to the public. Mr. Emmott would have been prepared to put an independent accountant into the box to prove that, whereas he had suggested £4800 as the net income of the company during the past year, it had been over £5000, and for the last quarter at the rate of over £6000, so that any promise he made with regard to the company had been amply justified. Under these circumstances the parties had met fairly enough and made an arrangement, all imputations against Mr. Emmott being withdrawn. The parties were both journalists, and counsel trusted that for the future they would be good friends. The defendants were prepared to state that they intended to make no personal imputation against Mr. Emmott, and wished to withdraw anything which had been understood in that light. Under these circumstances plaintiff had obtained what he desired, and through him (Mr. Cock) had been able to make these statements, which, if anybody had taken an interest in the matter, they were perfectly in a position to verify by the best possible evidence that could be given.

Mr. R. T. Reid, Q.C., who appeared for "The Star," said that his clients were only fulfilling their duty as journalists in making criticisms. They never intended to make any allegations against Mr. Emmott, or in any way to cast any imputations upon him. The record was then allowed to be withdrawn.

It was a satisfaction to the plaintiff to be informed that the services of the gentleman who wrote the article complained of had been dispensed with.

ON the 19th ult. Messrs. Ropner and Son, Stockton, launched a steel screw steamer of the following dimensions—viz.: Length over all, 333ft.; breadth, 41ft. 6in.; depth, moulded, 24ft. Her triple-expansion engines are by Messrs. Blair and Co. Limited, and are of 1000I. H.P., with two large steel boilers, working at 160lb.

Metal Trade Memoranda.

The yield of gold in New South Wales last year was 144,000oz., being an increase of 2000oz. compared with 1891.

The Patent Shaft and Axletree Company, Wednesbury, have almost ready for starting the powerful new plate mill which they have been laying down. The extensions which this firm are now completing at their steelworks represent an expenditure of about £50,000.

In Montana the copper ore is combined with sulphur, antimony, and arsenic, and it requires a long series of smelting operations to secure pure copper, so that 10 per cent. ore; there, is no more profitable than 4 per cent. ore at Lake Superior. The Montana mines have, however, an advantage in the fact that one-third of an ounce of silver accompanies each per cent. of copper.

The silver ores of the Candamena Mine in Chihuahua, Mexico, contain bismuth in quantities varying with the amount of silver. The richest ores, yielding 20 per cent. of silver, generally have 15 per cent. of bismuth. A peculiarity of the ore is that the bismuth therein is invisible. The silver occurs as tetrahedrite, frequently rather cupriferous. The ore is treated by chloridising in the reverberatory furnace, 2oz. of salt being used per ounce of silver.

Official Gazette.

Partnerships Dissolved.

A. MORTON, H. GARDINER, and J. E. WOOD, under the style of Morton, Gardiner and Wood, Sowerby Bridge, engineers' tool makers.

C. POLYBLANK and T. S. PAYNE, under the style of the Payne Furnace Company, Swansea, engineers and agents.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Adjudication.

J. COLEY BROMFIELD, Threadneedle-street, City, London, engineer and managing director of the Kidwelly & Dinas Fire Brick Company.

New Companies.

PICKERING BLOCK AND HOIST COMPANY LIMITED.—This company was registered on the 21st ult., with a capital of £2000, in £1 shares, to carry on the business of mechanical engineers and general trades incidental thereto. Registered, without articles of association, by Jordan and Sons, 120, Chancery-lane, W.C. Registered office, 2, Mount Pleasant, Clerkenwell, W.C.

ST. MARTIN'S ELECTRICAL MANUFACTURING COMPANY LIMITED.—This company was registered on the 21st ult., with a capital of £500, in £5 shares, to manufacture and put up, or to acquire and use telephones, telegraphs, electric bells, phonographs, electric light, and all other electrical apparatus now known, or that may be hereafter invented, including the formation of electrical exchange centres. Registered by W. Alexander Thompson, 38, Coleman-street, E.C.

CARDIFF PONTOON AND ENGINEERING COMPANY LIMITED.—This company was registered on the 21st ult., with a capital of £15,000, in £10 shares, to adopt a specified agreement, and to carry on at Cardiff, or elsewhere in the United Kingdom, the businesses of builders, makers, and repairers of ships, steamers, barges, buoys, and vessels of every description, mechanical and manufacturing engineers, etc. The number of directors is not to be less than 1, nor more than 7. Registered by Gibbs, White and Crocker, 57, Gracechurch-street, E.C.

EASTON AND BESSEMER LIMITED.—This company was registered on the 24th ult., with a capital of £10,000, in £5 shares, to purchase and acquire the business carried on at Taunton under the style of Easton and Waldegrave, and known as the Whitehall Ironworks, and to follow the trades of ironfounders, metallurgists, electrical and general engineers, and other similar businesses in England or elsewhere. The regulations of Table A, with some slight modifications, apply. Registered by Waterlow and Sons Limited, London Wall, E.C.

EGGLESCLIFFE IRON COMPANY LIMITED.—This company was registered on the 24th ult., with a capital of £27,000, in £10 shares, to acquire and take over as a going concern the partnership, business, and undertaking carried on by Hy. Smith and F. W. Stoker, at the Egglescliffe Foundry, near Stockton-on-Tees, Durham, and to carry on the business of ironfounders, engineers, contractors, builders, ironmasters, smelters, etc. Unless otherwise determined by a general meeting, the number of directors is not to be less than 3, nor more than 5; qualification, £1000. Registered by C. J. Archer, solicitor, Stockton-on-Tees.

The Metal Market.

PRICES CURRENT.

LONDON, Jan. 30.

COPPER opened 2s. 6d. better and further gained 1s. 3d. owing to some sharp buying, the week's prompt making £45 7s 6d. to £45 8s. 9d., but the support was not long maintained, values rising to £45 17s. 6d. three months, and £45 6s. 3d. cash in nine days. Later on three months was reduced to £45 15s. on "short" sales, and with only moderate buying prices drooped to the close, late February passing at £45 7s. 6d., early February at £45 3s. 9d., cash at £45 2s. 6d., and three months at £45 11s. 3d. to £45 10s., the latter being taken after official hours. The close is easy at 2s. 6d. to 5s. decline. Sales, 1000 tons. Settlement price, £45 2s. 6d. English tough, £48 5s. Best selected, £49 10s. Strong sheets, £58.

TIN opened firm, and with buying by operators for the rise three months advanced from £92 17s. 6d. to £93 2s. 6d. before the first session closed. Cash was sold in small quantities at £92 10s, and £92 12s. 6d., but £92 10s. was again taken near the close, this, however, more marking buyers' than sellers' position. Final rates are fully 5s. better and firm, three months' closing quietly in the absence of business. Sales about 100 tons. Settlement price, £92 10s.; English ingots, £96.

PIG IRON opened with holders asking 45s. 6d. for 14 days and 42s. 6d. for three months, but buyers were reserved, and continued so all day. After the official close 45s. 2d. was bid for cash, but not accepted, and final rates were fully 2d. higher for Scotch, other sorts being unchanged. Settlement prices: Scotch, 45s. 1d.; Middlesbrough, 35s.; hematite, 45s. 9d.

TINPLATES remain dull, without change in quotation.

LEAD has been quiet, and closes 1s. 3d. easier at £9 16s. 3d.; English, £10.

SPELTER has ruled easy, and sales have been made at £17 10s., a decline of 3s. 9d., at which there are still sellers. Special brands from second hands, £17 15s.

ZINC SHEETS.—Silesian are offered at £20 15s. ex ship, but meet with only a limited sale. Belgian remained quiet. V.M. ex ship, £20 17s. 6d.; f.o.b. Antwerp, £20 15s.

OFFICIAL CLOSING QUOTATIONS.

	To-day.					
	£	s.	d.	£	s.	d.
COPPER—						
G. M. B.—Cash	45	2	6—	45	10	0
" Three months	45	11	3—	45	18	9
English tough	—		—		—	
Best selected	—		—		—	
Strong sheets	—		—		—	
TIN—						
Fine foreign—Cash	92	10	0—	93	0	0
" " Three months	93	0	0—	93	10	0
Australian—Cash	93	0	0—	93	10	0
PIG IRON—					s.	d.
Scotch warrants—Cash					45	1
" One month					—	
Middlesbrough—Cash					35	0
" One month					—	
Hematite—Cash					45	9
" One month					—	

GLASGOW, January 30.—Only a moderate business was done on the pig iron market, but the price of Scotch continued hard. About 14,000 tons were bought, nearly 13,000 at from 45s. 3d. to 45s. 1½d. cash; 500 at 45s. 2d. one month, open; and 500 at 42s., three months fixed. At the forenoon's close sellers asked 45s. 6d., but at the afternoon meeting they would have taken 3d. less. The shipments of Scotch last week were 6276 tons, an increase on the corresponding week of last year of 3128 tons, thus reducing the decrease for the year to 367 tons.

QUOTATIONS.

	Highest.		Lowest.	
	s.	d.	s.	d.
Scotch warrants—Cash	45	3	45	0
" One month	45	2	45	0
Middlesbrough—Cash	35	0	35	0
" One month	—		—	
Hematite—Cash	45	9	45	9
" One month	—		—	

Letters to the Editor.

*** *We do not hold ourselves responsible for opinions expressed by correspondents.*

*** *The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

*** *Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

TRANSVERSE STRAINS.

To the Editor of THE MECHANICAL WORLD.

SIR,—"Mechanical Draughtsman," of Belfast, appears to have met with the same difficulty that I did some time ago, at the apparently conflicting statements of different authors on transverse strains, breaking stresses, etc. For cast iron he says Rankine quotes 17,000lb. per sq. in., Molesworth 2·6 tons, and D. K. Clark about 7 tons. I have before me now Tredgold's, Tate's, Templeton's, Calvert's, and Anderson's, of the Royal Arsenal, and looking down the table of values of strengths they seem to give similarly contradictory statements. This puzzled me for a time, but on going thoroughly into the cases and examining the formulæ and tables, I find there is no perceptible difference after all are worked out according to the condition imposed by the various authors. I will just quote two—Sir John Anderson and W. Templeton, who both give Mr. P. Barlow as the authority from which their constant is derived. Anderson gives English oak as 557lb. for a constant; Templeton, 1672lb. for the same material as a value of strength. Both say it is the breaking weight. Taking the tables, they seem confusing, without we go into the conditions under which they were arrived at. Anderson arrives at his conclusions by taking the load as central and supported at both ends:—

$$\frac{\text{Breadth} \times \text{depth squared} \times \text{constant}}{\text{Length in feet.}} =$$

breaking weight, thus:—

$$\text{B W} = \frac{2 \times 3^2 \times 557}{6} = 1671\text{lb.} = \text{breaking}$$

weight of a beam 2in. broad, 3in. deep, 6ft. long.

Templeton arrives at his conclusions by taking his load at one end, and with the beam fixed at the other, then multiplying by 4 times for a central load supported at both ends:—

$$\frac{\text{Breadth} \times \text{depth squared} \times 4 \times \text{constant.}}{\text{Length in inches.}}$$

Thus:—$B\ W = \frac{2 \times 3^2 \times 4 \times 1672}{6 \times 12} = 1672$lb. breaking weight of a beam 2in. broad, 3in. deep, 6ft. long. I have not Rankine's, Molesworth's, nor D. K. Clark's tables by me, but from the values as above given by "Mechanical Draughtsman," and comparing them in like manner, he will find the same results. Thus, compare Anderson and Templeton as per the examples above, their constants being 557 and 1672:—

$$\frac{1672}{557} = 3.$$

Now compare Molesworth's 5800lb. and Rankine's 17,000lb. as constants in like manner, and we find these constants must have been arrived at under similar conditions:—

$$\frac{17{,}000}{5800} = 2{\cdot}93.$$

Thus we have 3 times as against 2·93 times, showing that this must have been the method by which Rankine and Molesworth arrived at their formulæ.

With respect to cast iron as per Anderson, it is 2548lb. for a beam supported at both ends and loaded at the centre, taking the length in feet as per formula above. Templeton gives 7650lb. with beam supported at one end and loaded at the other, taking the length in inches. If you work out these as per formulæ given with them, you will find the result exactly the same—viz., 2548lb. for beam supported at both ends and loaded in centre. For a beam supported at one end and loaded at the other, both work out to 637lb. as the breaking weight.

I should judge Rankine's 17,000lb. is for a cantilever with the load equally distributed, and Molesworth's 5800lb. for a beam supported at both ends and the load equally distributed.

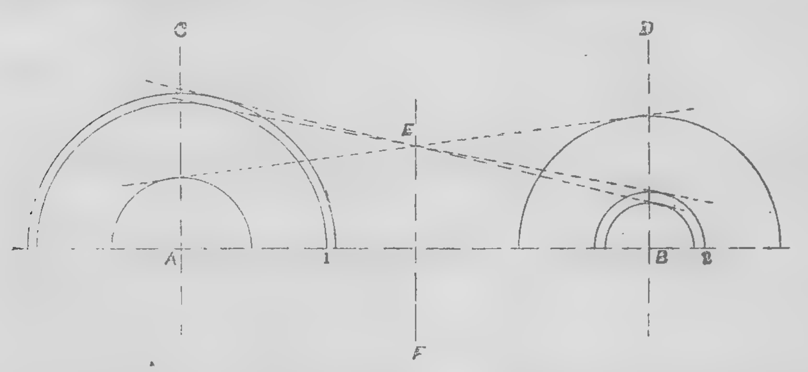
Leyland, Jan. 30. J. H. PILKINGTON.

SPEED CONES.

To the Editor of THE MECHANICAL WORLD.

SIR,—In my answer last week to your correspondent "W. S. M.," *re* "Speed Cones," I omitted to state that the formula given was very slightly inaccurate when the distance between the shafts is very small compared with the pulley diameters.

The following graphical method will be found quite accurate for all distances between the shafts. Referring to the accompanying diagram:—Draw centre line A B, and to as large a scale as possible; mark off the distance between the centres of the pulleys A and B, erecting perpendiculars through these points.



To the same scale, from centre A, describe the pulley diameters of the known cone, and from centre B describe the diameter of the known pulley in other cone.

Now erect perpendicular E F, half-way between the centres A B, and draw a line at a tangent to the known pair of pulleys 1 and 2, cutting line E F in point E.

If lines be now drawn passing through the point E at a tangent to the other pulleys of cone A, and circles be described from centre B at a tangent to these lines, the diameters thus found will be those necessary to cause the belt to run equally tight on each pair of pulleys.

If the above method is applied to the pulleys in question—drawing everything full size and placing the centres of shafts at the short distance of 30in., in order to make the discrepancy between the above graphical method and the formula given last week as great as is likely to occur in practice,—the results will be as follow:—

$19\frac{3}{4}$in.	$18\frac{1}{2}$in.	9in.	drivers.
$5\frac{1}{2}$in.	7in.	$16\frac{13}{16}$in.	driven.

ROBERT W. FIELDWICK.

London, Jan. 28.

METHODS OF LUBRICATION.

To the Editor of THE MECHANICAL WORLD.

SIR,—In your issue of January 6, you mention, in your "Miscellaneous Items" column, a method of lubrication by lubricating bags, amongst other things, for rolls.

Whilst admitting the advantages of this system over applying the grease with a brush or swab, and without wishing to depreciate its value for *light* machinery, we think it will be of interest to your readers to call your attention to what we think you and all other engineers will admit is a more scientific system of lubrication, and a decided advance upon the method above named.

In view of the fact that the real function of a lubricant is to act as a cushion, on which the journal or roll neck shall move without coming into actual contact with the bearing, obviously the best lubricant is that which has the greatest *body*, with the least tendency to gum, so that whilst keeping the journal and bearing well apart, the former may ride freely on it.

For heavy work, it is impossible for lubricant with sufficient body to percolate through the meshes of a bag, and we think far better results are obtained by having a block of lubricant sufficiently hard to only just wear away enough for lubrication, without any waste. By this means the brasses, too, are protected far better than with softer lubricant.

THE GLYKOLINE LUBRICANT CO. LTD.

Middlesbrough, Jan. 16.

ACCIDENTS TO HOISTING MACHINERY, AND THEIR PREVENTION.

To the Editor of THE MECHANICAL WORLD.

SIR,—I have read the article on the above subject, which appeared in your issue of the 20th ult., with much interest, as I have had charge of a number of hoists of various types, by different makers, for the last 20 years. From the reports of accidents which often appear in the newspapers and mechanical journals, I often think that this piece of useful machinery does not receive the care and attention necessary to prevent accidents. There is no doubt whatever that hoists in factories and warehouses of any pretensions are simply indispensable at the present time, and are far more likely to increase than decrease in the future.

I would here remark that one cannot point out every defect and suggest a remedy for same in an article such as that referred to, and I may be pardoned if, with all due respect to the writer, I add a few hints, which I hope may be of some value to factory and warehouse owners, and perhaps be the means of preventing the loss of life or limb of some fellow-worker.

I quite agree with the writer of the article that careful and regular inspection by a competent party should be imperative, and the least sign of weakness made good at once.

But as to the complicated appliances such as he has described to prevent the cage from falling to the bottom, I may say that I have no faith in them, and, judging from the description he has given of some of their operations, I think he is in much the same mind. Therefore, to prevent such a calamity, I would strongly advise the following golden rule:—Hang the cage by two ropes or chains, each strong enough to carry the heaviest load without danger, and so fastened that they are quite independent of each other, and so that each takes an equal share of the burden. When they are worn to about what an experienced man may think half their life, take one off and put on a new one, and then by the time the old one shows signs of giving way you will have a good one alongside of it, quite able to take the whole of the burden even should the old one break before you are able to have it replaced. But one point must always be kept in mind: Don't run them too long before getting the new rope put on; ropes don't cost much, and if you err, err on the safe side. By continuing this system you will always have one good rope to stand between you and danger. As to over-winding in hoists, I should have thought that a thing of the past. In my opinion hoist gears should all be so constructed that they will automatically disengage themselves from the driving gear at top and bottom of the shaft A very simple automatic appliance does this with certainty, as I never knew one to fail. In making arrangements to prevent accidents, you cannot do better than appoint one man to be responsible for the proper working of your hoist. One half of the accidents recorded are caused by someone who knows nothing about the working of the hoist taking liberties with it. Doors or gates on the side of the hoist shaft should all be so arranged that they cannot be opened from the outside, but only from the inside by the man in charge, and he should see them properly shut before leaving. Each door or gate should have a bell so fixed in the hoist shaft that it can be rung from the outside and easily heard by the man in the cage. These bells should differ from one another in tone, so that the hoistman knows by the tone of the bell which door he is wanted at. Another good thing to prevent accidents is to have rules (to guide the workers who may be travelling up and down the hoist) engraved on a brass plate, and so fixed on the side of the cage that it can be easily seen by all, and the penalty for violating any of these rules should be instant dismissal.

All our hoists are fitted up as I have described, and have been in use for nearly twenty years, and we have never had any accident or trouble with them, although dozens of people, old and young, pass up and down them every day.

Dalry, Jan. 25. G. W. McQ.

Miscellaneous Items.

The Hydrographic department of the Admiralty, it is stated, is about to be reorganised.

A lighthouse about to be built near Keyport, New Jersey, will be of steel plates, and will be 100ft. high.

The first locomotive built in Australia has just been completed at the works of Messrs. David Munro and Co., Melbourne, for the Victorian Government railways. It is similar to a number in use on those lines, and is a tank engine, having four coupled driving wheels, 5ft. $0\frac{1}{2}$in. in diameter, a pair of leading wheels, 3ft. 6in. diameter, at the forward end, and a pair of trailing wheels of similar dimensions.

There has recently been discovered in the stream close to the Zimbalye ruins, Mashonaland, what the finders thought to be good alluvial gold. This now proves to be beads of solid gold, undoubtedly from the old crucibles of the earlier workers. Amongst these pieces were found some complete manufactured gold beads. Sir John Willoughby, with his staff of workmen, have found numerous curios and old crucibles that were used for smelting gold.

The Lancashire Vinegar Company, Radcliffe, have recently had fixed for them by Messrs. Henry Roberts and Co., Mile End road, London, one of three large vats for the storage of malt vinegar. The circumference is 50ft. 3in. at the base the diameter is 16ft., and at the head 14ft. 5in.; the staves are 16ft. $3\frac{1}{2}$in. in length, and the iron hoops which encircle it measure 940ft. It is made of English oak, and the weight of timber is about five tons. The storage capacity is 20,000 gallons, which will weigh nearly 90 tons. A party was held in the vat, the accommodation being sufficient for 24 persons.

In 1892 the Mint purchased 2,647,517·53oz. standard silver bullion at an outlay of £439,454 2s. 4d. The mean price per ounce was 39 15-16d., and the seigniorage yielded on the coinage amounted to £288,613 4s. 4d. During the year 20,785,206 imperial gold pieces were struck. Of silver, 15,901,395 imperial and 15,581,000 colonial pieces; and of bronze, 13,867,246 imperial and 1,200,000 colonial, making respective totals of 31,482,395 and 15,067,246 pieces struck by the Mint. The aggregate number of pieces thus struck in the course of the year amounted to 67,334,847.

At the William H. Colliery of the Conelln Coal Company, located in Duryea, Pennsylvania, where the average daily output is 1200 tons, a feature of special interest is the electric pump. This is the first electric pump introduced in the mines of that section, and its successful operation is being watched with great interest by all interested in mining matters. The pump is of the horizontal, triplex or three-plunger type, with $6\frac{1}{2}$in. plungers and 8in. stroke. It makes 42 revolutions per minute, and in its present position throws a steady stream of water through a 4in. pipe a distance of 500ft. from the lower workings to the main pump. The capacity of the pump is 500 gallons per minute. Its entire weight, inclusive of the operating motor, is 6600lb. The electric motor is a $7\frac{1}{2}$H.P. General Electric Company's motor, and the generator constructed by the same company, and placed in the main engine-house on the surface, is of 10H.P. The power is transmitted to the motor over copper wires running down through the air shaft and along the roof of the mine for a distance of 1700ft. The pump and motor are mounted upon a wheeled truck, and can thus readily be transported to any point in the workings.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

POOLE'S GRINDING MACHINE FOR LATHES.—Required, the address of makers of this machine.

FILTRATION.—Will any reader state the best method of filtering 150 gallons of canal water per day for steam-boiler purposes?—T. H. MITCHELL.

TWIST DRILL CUTTERS.—Can any reader give me a method of getting the correct thickness and shape of cutter for any diameter of twist drill, straight lip? A drawing will greatly oblige.—J. M. F.

"GRASS" PACKING.—Can any reader supply me with the address of manufacturers of this packing? I have seen it used for the piston and valve rods of L. and N.-W. Railway engines.—LOCO.

ENGINEERS WAGES.—Would any reader kindly give me some information as to the wages at Cape Colony and Mexico for mechanical engineers?—REGULAR READER OF "THE MECHANICAL WORLD."

HEATING FURNACE.—Will any reader kindly give particulars, with rough sketch, of furnace suitable for heating and fagotting iron up to 3in. diameter and about 2ft. long for 2cwt. steam hammer?—HAMMER.

ELECTRICAL RESISTANCE.—Can any reader give me any information relative to the resistance offered to the passage of electricity by carbon rods and platinium wire? Is there a small work published on the subject? If I had formula, I could work out myself.—CARBON.

LOSSES IN STEEL FURNACES.—Could any reader kindly inform me the average per cent. of actual loss, and the average per cent. of skull, in the charge of a Siemens open-hearth steel furnace working charges of from 30 to 40 tons? And also the percentage of loss in heating slabs and ingots in the Siemens regenerative gas furnace?—J. R. R.

PURE COPPER CASTINGS.—Will any reader kindly tell me the way I can cast pure copper castings free from tiny holes, which often show themselves when machined. They are generally found with a whitish metal with it. What firm could supply such castings free from the above defects, and at the same time pure?—PURE COPPER.

COAL MINING.—Will some reader of THE MECHANICAL WORLD kindly say how many tubs should be run each journey to work an incline of 1 in 14 and 1100ft. long, so arranged that the full tubs going down will bring up the empty ones? Weight of tubs, full, 15cwt.; empty, 5cwt. each; would two tubs each journey be sufficient? Which would be the best to lower the tubs with—a brake drum or a horizontal brake pulley? Please say how to calculate the weights for working inclines of various gradients when arranged as the above.—AUTOMATIC.

WINDING ENGINE.—What weight would a pair of 36in. cylinder engines by $4\frac{1}{2}$ft. stroke raise from a pit with a spiral drum, commencing at 14ft. and finishing at 18ft. diameter, one side to wind from a depth of 350yds. and the other side from 400yds.; ropes to be $1\frac{1}{2}$in. diameter, boiler pressure 80lb. per square inch, cut-off at $\frac{3}{4}$ stroke? What weight would the above engines raise from a depth of 280yds., with a flat rope drum, commencing at 12ft. diameter; sizes of ropes $5\frac{1}{4}$in. by $\frac{5}{8}$in. (steel)? What would be the rise in inches per yard of a slant whose angle is 26 degrees?—MINER.

BRAKE-WHEELS, WINCHES, ETC.—(1.) Are there any reliable rules for the design and construction of brake wheels and straps; also, what is the method of calculating the strains on the above as applied to cranes, crabs, and winches? (2.) Is there any formula for finding the diameter and width necessary for a roller on jib bottom to travel on roller path? (3.) What is the method by which the strains on the sides of crabs, winches (C. I. and W. I.), A, circular and other designs of frames, are worked out? Any information on the above would greatly aid.—F. W.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

MANAGER.—No address given.

ONE IN A FIX.—See reply to "Manager."

ANXIOUS TO KNOW.—See reply to "Manager.

R. GRIERSON.—Yes, it is very slightly compressible.

W. H. UNSWORTH.—It is purely a question of what intensity of stress is allowed.

P. THOMPSON.—We are obliged for the cuttings, which, however, we had already seen.

ENGINE KEEPER.—Apply to Messrs. Bateman and Co., model-engine makers, High Holborn, London.

VERROR NE.—We think you will find all the particulars you require in our issue for March 8, 1890.

ENGINEER.—A duplex pump—as, for example, the Worthington—would best answer your purpose.

ALPHA.—Salomon's "Management of Accumulators," price 3s., will suit you. It may be had from our office.

J. M. K.—(1.) We cannot say. (2.) The only way is to well wrap up the pipes with hay, felt, or similar material.

LEON.—We would advise you to read Anderson's "Strength of Materials" (3s. 6d.), which may be had from our office.

SUBTERRANEAN.—Double-ported slide valves enable a large port area to be used with only a moderate valve travel.

PAT. EASTLEIGH.—"Continuous Railway Brakes," by Reynolds (9s.), will suit you. It may be had from our office.

HANLINE.—Write, giving full particulars to the Manager, Printing Department, Messrs. Emmott and Co., Limited, at this office.

TAFF VALE.—We think "The Modernised Templeton" (6s.) would best meet your requirements. It may be had from our office.

E. JONES (Brussels).—Grease the rust stains, and after a few days rub with a cloth moistened with ammonia; wash the articles, and when dry polish them.

J. M. W.—(1.) The agent for "Soennecken's" German round writing books and pens is Mr. S. Maier, 35, Aldermanbury, London, E.C. (2.) Inquire of the secretary, Commercial Department, Board of Trade, Whitehall, London, S.W.

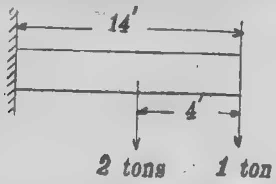
"THURIOUS THRY."—(1.) Urquhart's "Electric Light," 7s. 6d. (2.) "Brick and Tile Making," by Dobson, 3s. These may be had from our office. (3.) Messrs. Peters, Bartsch and Co., Derby, have a good process. (4.) We are not aware of any such process.

SQUARE SHAFTS FOR CRANES.—I shall be glad if any reader can give me the names of any firms who make a specialty of large square shafts for cranes.—INQUIRER.——*A.*—Messrs. J. Rogerson and Co., Stauners Closes Steelworks, Wolsingham, viâ Darlington will be able to supply you.—LONG MINER.

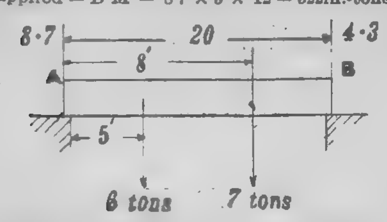
SPEED CONES.—I have a speed cone, the diameters of which are 19¾in., 18½in., and 9in. I want the 18½in. to drive a 7in. pulley. Will some one give me a rule for calculating the diameters of the other two pulleys?—W. S. M.——*A.*—If I understand the requirements of W. S. M. rightly, he wishes to have a movable belt, as in the case of lathe cones, etc., and has decided on a 7in. pulley, working in conjunction with the one of 18½in., and desires the sizes of the largest and smallest pulleys of the driven cone. Rule: Add together the 18½in. on driving cone and the 7in. centre pulley of driven cone; then subtract 9in. from that sum, the answer will be the largest pulley on driven cone. Follow the same course to find the smallest pulley required. Thus: $-18\frac{1}{2} + 7 = 25\frac{1}{2}$, and $25\frac{1}{2} - 9 = 16\frac{1}{2}$ large pulley. The sizes of pulleys on the driven cone are 5¾in., 7in., and 16½in.—J. H. PILKINGTON.

HEATING STEEL.—Would any reader kindly explain the following?—If one takes a piece of steel, heats it to redness in a fire, then chalks it over and dips it into cold water, it is as soft as iron when it comes out.—GOOD TEMPER.——*A.*—When hard high carbon steel is annealed the carbon is combined with the iron as carbide carbon. When the steel is heated above 700°C. the carbon is dissolved as hardening carbon. Now, if the steel is suddenly cooled from above 700°C., the carbon remains as hardening carbon, and you have hard steel. But if you let the steel cool slowly below 700°C. the carbon changes into carbide carbon, and you have soft steel. Now, while "Good Temper" was chalking his steel it cooled below 700° C. and the carbon changed into carbide carbon, so that his steel, although quenched, would be quite soft. The chalk probably had nothing to do with it. It was merely cooling in the air to below 700° C. If "Good Temper" wants more information on the subject he had better consult the "Proceedings of Iron and Steel Institute" or Prof. Roberts-Austen's book on "Metallurgy."—WATER METER.

STRESSES IN BEAMS.—(1.) What is the shearing force and bending moment at the fixed end of a bracket whose length is 14ft., and which carries one ton at the free end and two tons at 4ft. from that end? (2.) A beam of 20ft. span, supported at both ends, carries a weight of 6 tons at 5ft. from one support, and another of 7 tons at 8ft. from the same support. Calculate the reactions at each support, and the bending moments at each load.—R. B.——*A.*—The following are answers to the questions about stresses in beams that appeared in last



week's MECHANICAL WORLD:—(1 ton × 14ft.) + (2 tons × 10ft.) = 34ft.-tons, or 408in.-tons = bending moment at the support. The shearing force is equal to the total load, or 3 tons. The reactions at A and B are:—$B \times 20 = (7 \times 8) + (6 \times 5) = 86$. $B = \frac{86}{20} = 4.3$ tons. $A \times 20 = (7 \times 12) + (6 \times 15) = 174$. $A = \frac{174}{20} = 8.7$ tons. Bending moment at point where the 6-tons load is applied = B M = $8.7 \times 5 \times 12 = 522$in.-tons.



Bending moment where the 7-tons load is applied = B M = $(8.7 \times 96) - (6 \times 36) = 619.2$in.-tons. This is the section most stressed, and where the beam would most likely break.—D., JUN.

BLOWERS v. FANS.—Will any reader supply me with some reliable data for calculating the power required to drive blowers and fans? I would also be glad of an opinion with regard to their comparative merits in blowing blacksmiths' fires.—POWER.——*A.*—In answer to "Power," I wish to point out that a great deal of ignorance exists as to the true efficiency of fans or blowers. The number of recorded experiments with fans is very small, and Mr. Buckle is one of the very few authorities on this subject. A paper by Mr. Buckle on "Experiments Relative to the Fan Blast" will be found in the "Proceedings of the Institute of Mechanical Engineers" for 1847. Some information on this subject will be found in D. K. Clark's "Manual of Engineering Data," taken from Mr. Buckle's paper of 1847. Molesworth gives scant information, his formulæ being:—$H.P. = 0.000016 V^2 A P$. P = pressure of blast in lb. per square inch; A = area of the sum of tuyeres in square inches; V = velocity of tips of fan in feet per second. The work done by a fan consists in imparting to a certain weight of air previously at rest motion at some velocity. The velocity at which the air leaves the fan cannot be greater than the velocity of the fan tips; with a good fan it may be two-thirds of that speed. The resistance to be overcome will be found by multiplying the area of the fan blades by the pressure of air, and by the velocity of the centre of effort, this varying with the shape of the fan blades. The velocity imparted to the air will be the same as though the air fell in a mass from a given height. This height is found by the formula $h \frac{v^2}{64}$. If the velocity be multiplied by itself and divided by 64 we have the height. Thus, assume the velocity to be 88ft. per second, then $88 \times 88 = 7744$, and $\frac{7744}{64} = 121$. The pressure against the fan blades will be equal to that of a column of air of the height due to the velocity, as in this case 121ft. Let us say 13 cubic feet of air weigh 1lb., then a column of air 1ft. square and 121ft. high, or $\frac{121}{13} = 9.3$ = resistance in lb. per square foot overcome by the fan. If the area of all the fan blades be, say 2ft., and the velocity at the centre of effort be 90ft. per second, then the power expended will be

$$\frac{90 \times 60 \times 2 \times 9.3}{33,000} = 3.04 \text{H.P.}$$

The quantity of air delivered ought to be equal in volume to that of a column with a sectional area equalling that of one fan blade moving at 88ft. per second. The blade having an area of 1 sq. ft., the delivery ought to be 5280ft. per minute, weighing $\frac{5280}{13} = 406.1$lb., less friction, etc. If "Power" will consult the "Engineer" for 1883, he will find a deal of information on fans.—J. M.

Prize Competition.

WE OFFER FOUR GUINEAS MONTHLY IN PRIZES FOR THE BEST ORIGINAL ARTICLES SENT IN ON ANY MECHANICAL, ENGINEERING OR ELECTRICAL SUBJECT.

IN ORDER THAT MANAGERS, DRAUGHTSMEN, FOREMEN, AND WORKMEN WHO HAVE HAD NO PRACTICE IN WRITING MAY NOT HESITATE TO SEND IN COMPETITIONS, IT IS TO BE UNDERSTOOD THAT ALL ARTICLES WILL BE FULLY EDITED AND CORRECTED, AND JUDGED OF SOLELY ON THEIR MERITS AS ORIGINAL CONTRIBUTIONS FROM A PRACTICAL POINT OF VIEW. THE OBJECT OF THE COMPETITION IS TO INDUCE PRACTICAL MEN TO COME FORWARD AND GIVE THE RESULTS OF THEIR EXPERIENCE.

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Written competitions must be on one side of the paper only. The contributions must be original, and relate to matters connected with Engineering, Mechanism or Electricity.

The Proprietors of THE MECHANICAL WORLD reserve the right to publish any competition, whether it gains a prize or not.

The competitions may be accompanied by diagrams' sketches or drawings.

Competitors should write the words "Prize Competition" on the envelopes.

Competitors are not confined to one, but may send any number of competitions.

The correct name and address of the sender *must* be distinctly written upon every competition, not necessarily for publication. Competitions can appear under a *nom de plume*.

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Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

13th January, 1893.

765 UTILISATION of PEAT in the CONSTRUCTION of ROADS or RAILWAYS. J A Rossiter.
767 GROUND COMPASSES. W Low.
775 ELECTRIC ARC LAMPS. E Conrady.
779 APPARATUS for AUTOMATICALLY REGULATING the TEMPERATURE of the Water USED in COOLING the CYLINDERS of GAS and OIL ENGINES. A Shiels.
785 BALANCED SLIDE VALVES.* E K Dutton. (*J P Lightbody*, United States.)
790 PRESSURE-REDUCING VALVES. W T Ellison.
791 DEVICES for OPENING and CLOSING ELECTRICAL CIRCUITS. J H Tucker.
803 EQUILIBRIUM SPINDLE VALVE. L W Douthwaite.
813 ELECTRODES for ELECTRIC ACCUMULATORS. C Pollak.
814 DYNAMO or MOTOR BRUSHES. F H Judson and W J Woodward.
822 APPARATUS for USE in PROTECTING IRON and STEEL by PRODUCING MAGNETIC OXIDE THEREUPON. A S Bower.
833 FERRULE for STEAM BOILER TUBES. D J Morgan.

14th January, 1893.

841 ELECTRIC ILLUMINATION of CLOCKS. Sir D L Salomons, Bart.
845 PROPELLING APPARATUS. E J Warmington.
847 VALVES of STEAM ENGINES. A Sowden.
856 TURBINES. F G M Stoney.
854 SIMPLEX SAFETY VALVE.* H Hainsworth.
857 VENTILATING APPLIANCES. J D G Thompson.
874 APPARATUS for CHARGING GAS RETORTS.* J Webster.
876 BOX-NAILING MACHINES. H J McDowall and J Barr.
884 PERMANENT WAY of RAILWAYS. J Wilkinson.
887 COMBINATION TOOLS and TOOL-HOLDERS. J D Pigott.
896 APPLIANCES for PREVENTING DAMAGE and LOSS of LIFE by COLLISION of TRAINS on RAILWAYS. J Favets.
898 SCREW PROPELLERS. J C Bull.
899 MARINE STEAM ENGINES. F T Marshall.

16th January, 1893.

906 HYDRAULIC MAIN VALVE for GAS, TAR, and AMMONIACAL LIQUORS. F S Cripps.
916 AUTOMATIC COUPLING for RAILWAY CARRIAGES and TRAMCARS. J J E Lenoir.
922 FOG SIGNAL. A Flory.
923 COMPASSES for HOLDING PENCILS. C Smith and others.
933 ELECTRICAL ARC LAMPS. W H Lauder.
939 AIR COMPRESSORS for USE in RAISING LIQUIDS in MINES and QUARRIES. E Evans and others.
940 SIGNALLING RAILWAY TRAINS. W Tillett.
943 INGOT MOULDS. T L Binney.
947 SEMI-METALLIC ENGINE PACKING for PISTON and VALVE RODS. H Brandon.
949 WATER-TUBE STEAM BOILERS. J and J E Mills.
952 BEARINGS for the DRIVING SHAFTS of SCREW PROPELLERS. L A Legros.
956 COUPLING MECHANISM for TRANSMITTING MOTION to TRAMWAY CARS.* C Lührig.
962 DIES for USE in STAMPING or PUNCHING BLOOMS.* C G Larson.
965 METER for WATER and OTHER LIQUIDS. B J B Mills. (*H Rostagnat, jun.*, France.)
968 BOILERS or STEAM GENERATORS. M W Household and G P Garratt.

17th January, 1893.

970 HEATING a DRAUGHT to be FORCED THROUGH the FURNACES of and for VENTILATING SHIPS USING STEAM. T M Rymer-Jones.
971 PROPELLING SHIPS and BOATS. G Wells.
972 AUTOMATIC RAILWAY SIGNAL and BRAKE OPERATOR. B Fairlee.
974 WRENCH for TIGHTENING and LOOSENING NUTS. F Pickles.
975 APPARATUS for EJECTING OIL on TROUBLED WATERS from SHIPS. R Baird and J Cochrane, jun.
976 AUTOMATIC RAILWAY CARRIAGE DOOR FASTENER. E Oades.
978 ANTI-FOULING and ANTI-FRICTION COMPOSITION for SHIPS' BOTTOMS. E H Braidwood.
979 HIGH-SPEED BOILER and GEARING. W Bradshaw, jun.
982 TELEMETER SYSTEMS for INDICATING and RECORDING MOTIONS of ROTATORY PARTS of MACHINERY.* A G Brookes. (*F J Dibble*, United States.)
983 TELEMETER SYSTEMS for INDICATING and RECORDING MOTIONS of ROTATORY PARTS of MACHINERY.* A G Brookes. (*F J Dibble*, United States.)
985 APPARATUS for INDICATING at ONE STATION TEMPERATURES or ATMOSPHERIC PRESSURES EXISTING at VARIOUS PLACES. J Bartlett.
987 GRIP WASHER for BELT FASTENERS. R and B G Simpson.
988 MACHINERY for CUTTING and BORING COAL and STONE. T Heppell and others.
990 DEVICE APPLICABLE for the CIRCULATION of WATER in WATER JACKETS. F G Paynter.
998 APPARATUS for WETTING CORUNDUM WHEELS and GRINDSTONES when in MOTION. H Knight.
1004 COUPLING CONTRIVANCES for RAILWAY TRUCKS and CARRIAGES. M Pincus.
1005 ELECTRICALLY CONTROLLING RAILWAY SIGNALS and POINT LEVERS. C M Anderson.
1014 AUTOMATIC BLOCK SIGNAL. S Wallis and T Weller.
1017 APPARATUS for PRODUCING WATER GAS and HYDROGEN. W and R Young.
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1031 TURNING LATHES. W Taylor and others.
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1051 STEAM GENERATORS or BOILERS. A S Bower.
1053 RAILWAY VEHICLES.* F U Adams and R W Hamill.
1054 STEAM BOILERS.* H A Laughlin.
1055 STEAM ENGINES.* E H Johnson.
1056 METALLIC PACKING for PISTONS and PISTON RODS.* H H Lake. (*T Tripp*, United States.)
1057 ELECTRIC RAILWAYS. H H Lake. (*T Harris*, United States.)
1059 MINERS' SAFETY LAMPS. P M Chester.
1064 MOTORS.* T A Stark and J C Ortlepp.
1065 SECURING the COTTER of a SLOT BOLT. C M Stetson.
1070 GAS ENGINES. H T Dawson.
1071 BELTS. A Walter.
1077 ELECTRIC TELEPHONE SWITCH APPARATUS.* W P Thompson. (*C C E Lesenberg*, Germany.)
1083 SCREW PROPELLERS. H Cloughton.
1085 PRESSURE REGULATORS for RAILWAY BRAKES. M L E Duval.

18th January, 1893.

1089 BLOWERS and SMOKE-CONSUMING APPARATUS.* M R Ruble.
1092 LIDS and FASTENINGS for SELF-SEALING GAS RETORT MOUTHPIECES. W A Laurie.
1093 BORING MACHINES. A H Morier and J M Collins.
1098 RAILWAY JUNCTION ELECTRIC SIGNALLING. W E Langdon.
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1116 EXTRACTION of GOLD and SILVER from ORES. C M Pielsticker.
1118 APPARATUS for SIGNALLING UPON RAILWAYS. G South.
1127 DIFFERENTIAL PULLEY BLOCKS.* W P Thompson. (*E Y Moore*, United States.)
1141 PANTOGRAPHS. W B Pinhey.
1144 CASTINGS.* W A Polster.
1152 MOTOR. H Martin and P R J Willis.
1154 REVOLVING FIRE GRATE. F Carel and W F Davidson.
1155 METAL-SEAMING TOOL. P Willis. (*C H A Dissinger*, United States.)

19th January, 1893.

1166 ELECTRIC SWITCHING DEVICES. H R Wood.
1178 FURNACES of STEAM BOILERS. W Ball.
1191 COMPRESSED AIR, GAS, and WATER MOTOR. J R Sewell.
1198 MULTIPLE CARBON ARC ELECTRIC LAMPS. J Brockie.
1199 VALVES PLACED INSIDE BOILERS for AUTOMATICALLY STOPPING the ESCAPE of WATER and STEAM.* J Baldwin.
1206 STEAM BOILERS. J H Fraser and others.
1217 ANCHORS. G Tyzack.
1219 SINGLE-PHASE ALTERNATE CURRENT MOTORS. C E L Brown.
1227 RAILWAYS BRAKES.* A J Boult. (*K G Fieke*, Germany.)
1229 SECONDARY or STORAGE BATTERIES.* H H Lloyd.

20th January, 1893.

1236 RAILWAY SIGNALLING APPARATUS. W Shelly and J Greenall.
1237 EMPLOYMENT of ALUMINIUM for the CONSTRUCTION of MEDICAL APPLIANCES in the SHAPE of APPARATUS, FRAMES, SPLINTS, ETC. H R H Bigg.
1255 INSTRUMENT for OPERATING the LOCK SCREWS of MINERS' SAFETY LAMPS. W Ackroyd and W Best.
1256 MINERS' SAFETY LAMPS. W Ackroyd and W Best.
1258 JOINING and SUPPORTING of RAILWAY RAILS. H E Trestrail.
1261 DYNAMO ELECTRIC MACHINES. E and E Conrady.
1267 OIL, ETC., ENGINES. W Woolidge.
1269 SETTING of GAS RETORTS.* W P Gibbons and R Masters.
1274 TUBULUS STEAM BOILERS. A R Sennett.
1277 GAS or EXPLOSIVE-VAPOUR MOTOR ENGINES. P Burt and G McGhee.
1281 PROPULSION of STEAMSHIPS. R Haddan. (*J F H Collet*, India.)
1284 MULTIPLYING DRIVING GEAR. C W Holmes.
1290 GAS GENERATORS. L Bemelmans.
1293 HAND DRILLS. W Ward.
1294 RAILWAY SIGNALLING APPARATUS. C E Fox.
1297 APPARATUS for PURIFYING WATER.* C Schmidt and E Loh.

21st January, 1893.

1309 DYNAMO ELECTRIC MACHINES. H Courteen.
1310 ENGINE GOVERNORS. C E Wolff.
1312 PULLEY or COUPLING for TRANSMITTING POWER. W Kingsland.
1314 PACKINGS for PISTON RODS. J H Hargreaves and others.
1336 AUTOMATIC SWITCH for OBTAINING CONTINUOUS ELECTRICAL CURRENT FROM a SERIES of OPEN CIRCUIT BATTERIES. E Blamire.
1343 INTERLOCKING APPARATUS for RAILWAY SIGNALLING.* S T Dutton.
1344 INTERLOCKING LEVERS in RAILWAY POINT and SIGNAL APPARATUS.* W G Scott.
1347 ANGLE-SYPHON of WHICH the DISCHARGE TUBE FORMS a PUMP.* J W Micheel.
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1355 APPARATUS for FORMING ELECTRO-THERMAL PLATES, TUBES, and CONDUCTORS. Sir C S Forbes, Bart.
1356 ELECTRIC GAS LIGHTING APPLIANCES and DEVICES.* A M Sloss.
1357 SET SQUARES.* F E Wilkins.
1358 LUBRICATORS. C Crowther.
1361 APPARATUS for FORMING or SHAPING ARTICLES of SQUARE or ANGULAR SECTION. G A Newton and J Fell.
1363 AIR PROPELLERS or FANS. C Myers and R Clarke.
1364 CONTROLLING and DISCHARGE VALVES for COMPRESSED AIR BRAKES.* W P Thompson. (*F A Holleman*, Holland.)

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The Mechanical World

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FRIDAY, FEBRUARY 10TH, 1893.

The City and South London Electric Railway.

Two years have passed away since the City and South London Electric Railway, pioneer line of its kind in the world, was set in operation, and since then the progress made has been one of steady improvement—improvement from a commercial point of view. It is, of course, from this standpoint that the future of similar undertakings in England largely depends, and those projects in Berlin, Brussels, Paris, and Madrid, for the construction of underground lines of the same nature, also rely for their practical carrying into execution to a certain extent upon the success of the London Electric Railway. The City and South London Railway (in which is invested nearly £900,000 paid-up capital, or received through debenture bonds and loans) has now yielded a dividend to the ordinary shareholders at the rate of ⅝ per cent. per annum for the half-year ending December 31, 1892. In the three previous half-years, and also for the last half-year, the interest on debentures and preference shares was duly paid, but the ordinary shareholders then received nothing. Thus it happens that for the past half-year the latter receive for the first time a dividend. True it is that the return to the ordinary shareholders is small, but the railway promises better results in the future. The financial position of the company has been strengthened during the past year by paying off some of the terminable debentures, and by the payment of every debt, and the company is now stronger than ever. A point of importance is the fact that during the first four weeks of 1893 the receipts from passengers increased by £150 per week, as compared with the corresponding period of 1892, and this augmentation is expected to steadily advance. Up to the present time the railway has carried no less than 12,000,000 passengers. The figures for the four half-years are as follow:—2,412,343, 2,749,055, 2,813,162, and 3,217,602 passengers. It will be seen how steadily the number is increasing. Now as regards the locomotive expenses, the chairman, at the meeting of the company on February 1, gave some interesting figures. In the first half-year the locomotive expenses—that is, those which are commonly comprised under the head of locomotive expenses in an ordinary steam railway—amounted to 9d. per train mile; in the second half they were reduced to 7·0d.; in the third half to 7·7d.; and last half-year they were 7·1d. As compared with steam lines which obtain their supply of coal at the pit's mouth, their locomotive expenses amounted to 5¾d. per train mile. The average number of passengers carried per train of three carriages during the four half-years was 45, 46, 47, and 48 respectively—truly a curious thing. The total percentages of expenditure of working to total receipts were respectively 79 per cent., 76 per cent., 70 per cent., and 67·9 per cent. of the receipts. These figures show how much more economical the railway is being worked. The receipts per train mile have slightly diminished, but this is the inevitable result of an additional service of trains and increased mileage run. The expenses per train mile, on the other hand, have diminished, being in the four half years 1s. 9½d., 1s. 7¾d., 1s. 7¼d., and 1s. 5¼d. respectively. On the whole the railway seems to be progressing in the right direction. Additional siding accommodation is at once to be provided at the Stockwell terminus, and this will enable the company to more readily deal with the traffic to the City. The extension of the railway to Clapham is not to be carried out at present. It may take some years before the railway is made a real commercial success, but the present tendency is in that direction.

English v. German Coal.

In a recent issue reference was made to the fact that the German Admiralty had ordered and received through intermediaries a large supply of English coal for the German Navy. This was confirmed by a telegram from Berlin last week, and according to which a question was asked at a sitting of the Budget Committee as to the reason why English coal was almost solely used in the German Navy during the past year. The reply stated, as given by the Secretary to the Navy, that as there was a lack of suitable coal in the market, a contract was concluded last March for the supply of English coal at 6s. 9d. per ton, free on board at the port of shipment; this resulting in an annual saving of £45,000. Now this despatch is rather misleading. As a matter of fact, the German Navy consumes 80,000 tons of coal annually, and it was about a quarter of this, or only 22,000 tons, which were purchased from England. When tenders were invited from German coal syndicates—for the individual colliery owners, generally speaking, would not treat direct with the Government—they quoted 12s. 6d. per ton, a price which was considered too high. Individual mine owners were, however, then approached, but only one offered a supply at 11s., and, notwithstanding the price, the terms were accepted. For further deliveries negotiations proceeded for some time, and lower rates being bid through a Hamburg dealer representing British coalowners, a contract was entered into for the supply, as previously mentioned, of 22,000 tons, which were delivered free at Kiel for 16s. 6d. per ton, whilst the German coal was 12s. per ton at the pit's mouth, and 4s. 2d. per ton higher than the former delivered at Kiel. One reason which may be adduced as the cause of the coalowners refusing to deal direct with the Admiralty, is the existence of the coal syndicates and sales bureaux. This will, however, no longer be the case, as a few days ago various colliery owners in Rhenish-Westphalia expressed to the Secretary to the Navy their willingness in future to negotiate direct with the naval authorities. One result which may be expected from this is a reduction in the rates for German coal, whilst there may be a possibility, in view of the different attitude adopted by the Teutonic coalowners, of English coal being excluded from participating—as it would in time of war—in open Admiralty contracts in that country. At any rate, the price of 16s. 6d. per ton at Kiel would not leave a large margin of profit to the English firms, especially on the kind of coal required for the German Navy.

The Proposed Vienna and Buda-Pesth Electric Railway.

New light, if the term may be accepted, was thrown upon the extraordinary project for the construction of an electric railway between Vienna and Buda-Pesth at a meeting, on the 2nd February, of the Danube Club, in Vienna, when Mr. J. Kareis, a well-known Austrian electrical engineer, presented a paper on the subject. The scheme, as elaborated by Mr. Zipernowsky, provides for the running of single cars, carrying forty passengers, at a high rate of speed, the current being generated, in addition to the terminal stations, also at subsidiary stations along the line. According to Mr. Kareis, the possibility of the trains running off the line would be excluded by reason of the special construction of the wheels and the line itself, and the power required for the propulsion of each car or train would be 800H.P. The interesting statements now come that the cost of building the line would amount to two and a half times that of constructing an ordinary railway, and that, taking into consideration the possibility of securing the whole of the present traffic of 200,000 passengers annually between Vienna and Buda-Pesth, there could be no return either in the way of interest on the invested capital or any provision for depreciation. In other words, the railway would result in a dead loss if the project was carried out. The cost of construction would, Mr. Kareis believes, be reduced if the proposed high speed was diminished to 93 miles an hour. It therefore seems fair to assume that the scheme will remain in abeyance; but it is worthy of note, after all the gusto with which the project has been promulgated, that the project is beyond the range of commercial possibility.

The Scotch Shipbuilding Trade.

The production of the Scotch shipbuilding yards during January is this year below the average; and although the work on hand still makes a respectable total, it furnishes no explanation of the decrease, but the prevalence of short time partly accounts for the one and sufficiently explains the other. Scotch shipbuilders launched 14 vessels of 12,800 tons, of which 7, representing 7300 tons, were steamers; 3, measuring 5020 tons, sailing vessels; and 4, totalling 480 tons, barges. To the total the Clyde contributed 6 steamers of 6300 tons and 7 sailing vessels of 5500 tons, and the Forth a steamer of 1000 tons. With a solitary exception, the production included nothing but vessels of the smaller classes and sailing ships of the ordinary kind, the only vessel above 3000 tons being the "Tritonia," built by Messrs. D. and W. Henderson and Co., Meadowside, for the Donaldson Line, of Glasgow. A screw steamer of 1000 tons was for the Bahamas; and the balance for British firms. The production of last January was 14 vessels of 16,024 tons. The Clyde proportion is 11,800 tons, made up of 6 steamers of 6300 tons, 3 sailing vessels of 4620 tons, and 4 barges of 480 tons. That is slightly better than last year. To the total Partick and Whiteinch contributed 6020 tons, Paisley, Renfrew, and Bowling 2580, and Port-Glasgow and Greenock 3200. Of the steamers, one was over 4000 tons, one between 500 and 1000, and 4 under 500. All the sailing vessels were between 1000 and 2000 tons. The Clyde production for the corresponding period of last year was 11,390 tons.

The Liverpool Elevated Electric Railway.

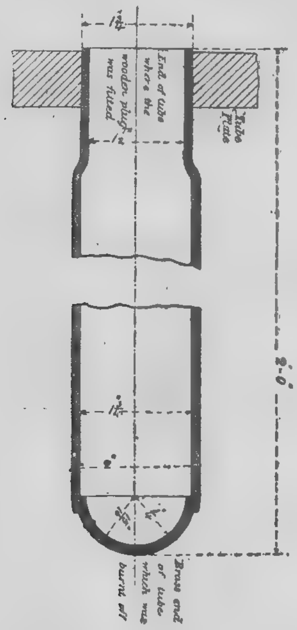
It was only in 1889 that a high-level railway was projected in Liverpool for the relief of the traffic along the docks, and at that time it was undecided as to what method of traction should be adopted. It was, however, soon resolved to introduce electric power, and with Sir Douglas Fox and Mr. Greathead as consulting engineers to the company, and the firm of Elwell-Parker (now the Electric Construction Corporation Limited), of Wolverhampton, as contractors for the electrical machinery, the railway has been brought to a successful issue. The railway was opened on the 4th inst. by the Marquis of Salisbury, in the presence of a distinguished assembly. The line has been so often described that it will only be necessary to briefly summarise its principal features. Generally speaking, the overhead railway consists of plate-iron girders, supported upon channel-iron columns, and carrying an iron flooring, upon which the permanent way is laid direct without the usual intervening ballast. The normal spans are 50ft., but there are some spans of 100ft. Tilting bridges are formed in some parts of the line so as to clear the ordinary vehicular traffic and to meet the requirements of the dock openings, whilst a special swing bridge is provided for crossing the entrance of the Stanley Dock. There are 13 stations, the passenger platforms being 120ft. long and 12ft. wide. Access to the platforms is gained in all cases from the street, and the most important stations have four stairs for facilitating the traffic. The plant at the generating station is as follows:—Six boilers of the Lancashire type, working at 120lb. pressure; four horizontal compound condensing engines, each of 400I.H.P.; and four Elwell-Parker dynamos, giving, at a speed of 400 revolutions, 450 ampères at 500 volts. The current is conveyed north and south along the railway by a steel conductor; this conductor is placed on porcelain insulators, which are supported upon cross timbers between the rails of each line. The current is collected by means of hinged cast-iron collectors, which slide upon the conductor, and from which it passes to the motors. An interesting feature is the fact that the motors, instead of being carried on a separate locomotive—as is the case with the City and South London Railway,—are arranged under the passenger carriages. A train consists of two carriages, each of which has a motor at one end. The carriages are arranged on bogie trucks, and the motors are so connected as to be controlled from either end by the driver. The carriages, which each accommodate 56 persons, carry both first and second-class passengers, and there is through communication from end to end of the train, under the control of the guard. A train with a full complement of passengers weighs 40 tons, and is fitted with the Westinghouse brake. The cost of the railway, including equipment, amounts to something like £85,000 per mile of line.

Recent Boiler Explosions.

(Continued from page 22.)

No. 576 inquiry is another instance showing the amount of ignorance and indifference displayed by those engaged in the East Coast fishing trade. We have commented upon many similar cases in these columns, and they still continue to occur frequently, notwithstanding the inquiries. In this case the boiler was a vertical one, used for hauling in the trawl gear, and had been in use 10 years, during which time it had never been inspected. As is common with this class of boiler, the uptake became very thin at the water line, and eventually corroded through. As the vessel was at sea and the resources were somewhat limited, the captain made an attempt to patch the defective part by covering it with a sheet of tin luted with Portland cement, and bound it on with wire. Such an arrangement could scarcely be expected to last long, and, of course, failed the first time steam was raised, seriously scalding the captain. From the great number of explosions on these East Coast fishing boats, often due to gross negligence, we have long expected seeing stronger measures taken. We are of opinion that so long as these cases end with preliminary inquiries nothing will be done to mitigate the great risk incurred by working these boilers under all sorts of conditions.

No. 577 refers to two cases of leakage which occurred on two different occasions in the furnaces. These were merely pittings which had gone through, and can only be classed as explosives by a long stretch of an elastic imagination. However, it served o show that the attendance was not of the est



Boiler Explosions.—No. 582

In No. 578 we once more come to copper steam pipes. In this case only one person was injured, though explosions of a less violent character have often caused the loss of many lives. Once more we have the old story of the "original latent" defect, perhaps aggravated by the rolling of the vessel. Had there been a better arrangement of pipes and expansion pieces this accident would not have occurred. We have before expressed ourselves strongly on the indifferent manner in which such pipes are made and fitted, and we are strongly of opinion that such conduct is doing much to hasten the adoption of wrought-iron and steel steam pipes on board ship.

No. 579 is another case in which the uptake of a vertical boiler had become so thin from corrosion as to be incapable of withstanding the working pressure. Fortunately no lives were lost, though the master of the vessel was present when the explosion occurred

No. 580 is again a copper steam pipe fracture. In this case it would appear that the pipe fractured in consequence of a shock caused by a sudden rush of water up the pipe when the main valves were being opened. The water would rush upwards from the long length of horizontal pipe, striking the elbow at the top, where it was found to be slightly thinner than at other places. Such an arrangement of pipes should be fitted with open drain pipes to ensure freedom from such mishaps. In any case, we think there was gross carelessness in not seeing that the pipes were free from water, as such an arrangement is most favourable to its accumulation; and this, by the way, appears to have been known from previous experience. Fortunately no serious injury to person resulted.

An Engineer's Notes.

TABLE OF SAFE LOADS FOR CAST-IRON COLUMNS.

(Ends Flat and Fixed.)

External Diameter.	Thickness of Metal.	Length of Columns in Feet.													Sectional Area.	Weight of Column per ft. of Length.
		6	8	10	12	14	16	18	20	22	24	26	28	30		
		Load in Tons.														
in.	in.														sq. in.	lb.
4	½	11	8·1	6·1	4·7	3·6	3·4	2·8	2·0	..	..	..	..	..	5·492	17·14
	¾	15·2	11·3	8·5	6·5	4·8	3·8	3·3	2·8	..	..	..	..	..	7·66	23·90
5	½	16·8	13·3	10·1	8·3	6·7	5·4	5·0	4·0	..	..	..	..	..	7·07	23·06
	¾	24	19	15	12	9	7·7	6·5	5·7	..	..	..	..	..	10·01	31·23
6	½	23	19	15·5	12·7	9·5	8·7	7·3	6·2	..	..	..	..	..	8·64	26·95
	¾	33	27	22	18	15	13	11	9	..	..	..	..	..	12·37	38·59
	⅞	37	31	25	21	17	14	12	10	..	..	..	..	..	14·09	43·96
	1	42	35	23	23	19	16	13	11	..	..	..	..	..	15·71	49·01
	1⅛	47	40	32	26	22	18	14	12	..	..	..	..	..	17·23	53·76
7	⅝	36	31	26	22	19	16	13	11	..	..	..	..	..	12·52	39·05
	¾	42	36	31	26	22	19	16	13	11	10	..	..	..	14·73	45·93
	⅞	48	41	35	29	25	21	18	15	13	11	..	..	..	16·81	52·51
	1	54	46	39	33	29	24	20	17	14	12	..	..	..	18·85	58·90
	1⅛	60	52	44	37	32	27	23	19	16	13	..	..	..	20·76	64·77
8	¾	51	45	39	34	29	25	22	19	16	14	..	..	..	17·08	53·29
	⅞	59	52	45	39	34	29	25	22	19	16	..	..	..	19·59	61·12
	1	66	58	51	44	38	33	28	24	21	18	..	..	..	21·99	68·64
	1⅛	73	64	56	48	42	36	31	25	23	20	..	..	..	24·30	75·82
	1¼	79	70	61	52	45	39	34	29	25	22	..	..	..	26·51	82·71
	1⅜	86	76	66	57	48	42	37	33	27	24	..	..	..	28·63	89·29
9	¾	60	54	49	43	37	33	29	24	22	20	18	16	..	19·44	60·65
	⅞	69	63	56	49	43	38	33	29	26	23	20	18	15	22·33	69·67
	1	78	71	63	55	48	42	37	33	29	26	23	20	17	25·13	78·40
	1⅛	87	78	69	62	53	47	41	36	32	29	25	22	19	27·83	86·83
	1¼	95	85	76	67	58	51	45	39	35	32	28	25	22	30·43	94·94
	1⅜	102	92	82	72	63	55	48	43	39	35	31	27	23	32·94	102·77
	1½	110	99	88	78	68	59	52	46	42	38	34	30	26	35·34	110·26
	1⅝	118	106	94	84	73	63	56	49	45	41	37	33	29	37·65	117·47
	1¾	125	113	100	90	78	67	60	51	48	44	40	36	32	39·86	124·36
10	⅞	80	73	67	60	53	47	42	37	34	30	27	24	21	25·08	78·28
	1	90	83	75	67	60	53	47	42	38	34	30	27	24	28·28	88·23
	1⅛	100	92	83	74	66	58	52	47	42	38	34	30	26	31·37	97·87
	1¼	110	101	91	82	73	64	57	51	47	42	38	33	28	34·37	107·23
	1⅜	119	109	98	88	79	69	62	55	51	46	41	36	31	37·26	116·25
	1½	128	117	106	95	85	75	67	59	54	49	44	39	34	40·06	124·99
	1¾	146	133	122	109	97	85	77	67	60	56	50	45	40	45·36	141·52
11	1	102	95	87	79	71	64	58	52	48	43	38	34	30	31·42	98·04
	1⅛	114	105	96	88	79	71	64	58	53	48	42	37	32	34·90	108·89
	1¼	125	116	106	97	87	78	70	63	58	52	46	41	35	38·29	119·46
	1⅜	135	126	115	105	94	85	76	68	62	56	50	44	38	41·58	129·73
	1½	146	136	124	113	102	92	82	74	68	61	54	48	43	44·77	139·68
	1¾	166	156	142	129	178	106	94	86	79	71	62	56	49	50·86	158·68
	2	186	176	160	147	134	120	106	98	90	81	70	61	55	56·55	176·44
12	1	115	107	97	92	83	76	69	62	58	53	48	44	40	34·46	107·51
	1⅛	128	119	108	102	92	84	78	69	63	58	53	48	43	38·34	119·62
	1¼	141	131	119	112	101	93	84	76	70	64	58	52	46	42·12	131·41
	1⅜	153	142	129	121	110	101	91	82	75	69	62	56	50	45·80	142·90
	1½	165	154	139	131	119	109	99	89	82	75	68	60	53	49·39	154·10
	1¾	189	178	159	150	137	125	115	103	94	85	78	68	60	56·26	175·53
	2	213	201	179	170	155	141	131	117	106	96	88	76	67	62·74	195·75
13	1	127	119	111	104	97	90	81	73	67	61	56	51	46	37·67	117·53
	1⅛	142	134	126	117	109	101	91	82	75	69	63	58	52	41·94	130·85
	1¼	158	149	140	130	121	112	101	91	84	77	70	64	58	46·11	143·86
	1⅜	174	163	154	143	133	122	111	101	93	84	78	70	64	50·19	156·59
	1½	190	178	168	157	145	133	121	110	101	92	85	77	70	54·16	168·98
	1¾	214	201	189	176	164	151	137	124	114	104	95	87	78	61·82	192·88
	2	227	224	210	195	182	168	152	137	126	116	105	96	87	69·09	215·56
14	1	138	131	125	117	109	101	92	85	78	72	66	61	56	40·9	127·60
	1⅛	153	145	139	130	121	112	103	94	87	80	73	68	62	45·5	141·96
	1¼	168	160	153	143	133	123	113	104	95	88	80	74	68	50·1	156·31
	1⅜	183	174	167	156	145	134	123	113	104	95	87	81	74	54·5	170·04
	1½	198	189	180	168	156	145	133	122	112	103	94	87	80	58·87	183·67
	1¾	226	216	205	192	179	166	152	140	128	118	107	99	91	67·31	210·00
	2	254	242	232	216	201	186	171	157	143	133	120	111	102	75·36	235·12
15	1	150	143	136	128	120	112	104	97	90	83	76	71	65	44·00	137·28
	1⅛	167	159	152	143	136	125	116	108	100	93	85	78	72	49·1	153·19
	1¼	184	175	167	157	148	138	128	119	110	102	93	34	79	54·0	168·48
	1⅜	201	191	182	172	161	151	140	130	120	111	102	93	87	58·9	183·77
	1½	217	207	197	186	175	163	151	141	130	120	110	102	94	63·7	198·74
	1¾	248	236	225	212	202	190	175	160	148	137	126	115	107	72·9	227·45
	2	279	265	253	237	229	216	197	179	166	151	141	127	119	81·67	254·81
16	1	161	156	150	142	133	125	117	110	104	95	87	80	74	47·1	146·95
	1⅛	179	173	167	158	148	139	130	122	116	106	97	89	82	52·6	164·11
	1¼	198	191	185	174	163	153	143	135	128	117	107	98	91	57·9	180·65
	1⅜	216	209	202	190	178	167	152	147	139	128	116	108	99	63·2	197·18
	1½	234	227	220	206	193	181	170	160	151	138	126	117	108	68·3	213·10
	1¾	268	258	250	237	224	207	199	183	173	158	145	133	123	78·3	244·29
	2	301	290	281	267	255	233	218	206	194	177	163	149	138	88·0	274·56

Note.—These loads are one-tenth of breaking weights, this proportion being adopted to allow for imperfections in casting, such as air holes, unequal thickness of metal, etc., deviation of line of pressure from axis of columns, and the effect of lateral forces accidentally applied. Where these risks do not occur, one-sixth may be taken as the safe load. If the ends of columns are not faced true, great care should be taken in the bedding.

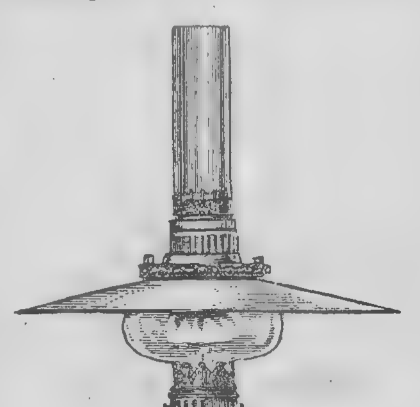
No. 581 refers to the failure of a mudhole joint owing to it being corroded at the face, and to the use of an unsuitable packing. Fortunately, in this case also there was no personal injury, or we fail to see how two engineers holding first-class certificates could have escaped the law. They knew of the defect, made no attempt to remedy it, and also knew the material used was unsuitable. We are rather inclined to think that had an engineer ashore (probably holding no certificate) used "⅜in. Tuck's packing" to make a boiler mudhole joint, something more would have been heard about it.

No. 582 refers to the formal investigation of an explosion which deserves more than passing notice. The Commissioners report upon it as a Field boiler, whereas it is merely a colourable imitation, without having the very necessaries essential to safety, the absence of which, together with the designer's want of knowledge of metals, brought about an explosion resulting in the loss of a valuable life. The Field tube and the Field boiler are well known, and with ordinary care are useful and safe; but such an imitation as here referred to can only have been worked with great risk. The Field tube, as is well known, is a vertical pipe, generally of iron or steel, made solid at the lower end which hangs in the fire, the upper end being secured in the firebox crown. This tube is fitted with an inner tube, generally of tin or other thin metal, and without this inner tube the Field tube is not complete. The duty of this inner tube is to induce circulation, which it does most efficiently by allowing the water to descend down the centre to replace the water thrown up in the generation of steam. Without this inner tube there cannot be any circulation, and in a very short time the lower end must burn out. The boiler had apparently been designed as a copy of the Field boiler, but the designer either did not know of, or did not understand, the inner tubes, so he left them out. A greater blunder, however, was in the making of the tubes, which were of copper, 2in. diameter outside, but reduced to 1¾in. where they were secured into the crown of the firebox; while the lower end of the tube, which hangs in the fire, was made solid by means of a brass cap, as shown in the sketch herewith. Any reasonably intelligent person would expect this to last a short time only, and such was the case, for one burnt out and the tube was plugged with a plug of iron. Shortly, a second tube burst through, burning through, and the maker of the boiler, calling in at the time, and there being no iron plugs handy, advised a wooden one, which was put in. When steam was raised this was blown out, scalding the engineer, who died from the effects. At the investigation some very strange points were raised, and the Commissioners ruled that although the advice given was voluntary and unofficial, the person who gave it was quite as responsible as if he had been officially called in and been paid for his services; they therefore fined him £20 towards the cost of the inquiry. From this it would appear that anyone recommending to a friend had better carefully consider his responsibility.

(To be continued.)

The "Golden" Gas Light.

The great advances which have been and which continue to be made in the application of electricity to lighting purposes, have caused increased attention to be given to gas lighting, and great strides have been made in the methods of employing the older form of illuminant—so much so, indeed, that in many cases the latter proves to be still not only the more economical system, but also the most advantageous in other respects.



Among recently-introduced gas lamps, that shown in the illustration herewith, called the "Golden Light," has attracted considerable attention. Briefly, it may be said that the burner is of the Argand type, but over the flame a hollow cone of refractory material is suspended, which deflects the flame, causing it to assume a saucer-like form, the result being that a very brilliant white light is produced. It may be said that the construction of the burner is very simple, and no parts are liable to get out of order or to require renewing. The flame is perfectly steady and can be easily regulated, while the economy effected over the ordinary methods of gas burning is very marked. Thus the larger size of burner made consumes slightly less than 10 cubic feet per hour, and gives a light equal to that given by four good ordinary burners consuming over 20ft. per hour. The smaller size consumes 6ft. of gas, and gives 50 per cent. more light than is obtained by burning the same quantity of gas in the ordinary manner. We may add that further particulars and prices may be had from Messrs. Ewart and Son, 346, Euston-road, London, N.W., who, we understand, have fitted up a special testing room, from which all outside light is excluded, so that

the illuminating power of this light may be compared both with the ordinary gas burners and also with the electric light, which are fitted up in the same room.

Mechanical and Engineering Drawing.—V.

By a Practical Draughtsman.

Before noticing the few "instruments" that are necessary when commencing the study of mechanical drawing, we think it

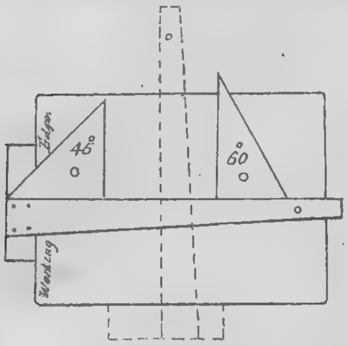


Fig. 7.

advisable to show, in a combined sketch (Fig. 7), the special tools—viz., drawing board, tee and set squares—recommended, that the student may note the position they each should assume when in use. The tee square should only be used in the two positions indicated by its outline in full and dotted lines. In the latter it will seldom be required. All lines at right angles to its edge, when in the first position, should be drawn with the 60° set square applied, as shown. The 45° set square is placed as it would be applied when a line is required at that angle near the left edge of the sheet of paper. Care should be taken, when drawing by lamp or gaslight, that the light is in such a position as to cause little or no shadow to be cast on the paper by the *edges* of the tee or set squares. This is important, as such shadows often cause errors in lining in, whether in ink or pencil. We may mention that the drawing board and tee square recommended for use are known as "Stanley's Improved," they having been invented many years ago by Mr. W. F. Stanley, of London.

The *drawing instruments* required by the student draughtsman are few in number, and should be acquired as the necessity for their use arises. No greater mistake can be made than that of purchasing a "box of instruments," as it generally contains some articles that are never required, and is wanting in those that are necessary for the special kind of drawing practised. All that the student requires for use for some time is a pair of 6in. compasses with a pen and pencil leg, pen and pencil bows, a ruling or drawing pen, and a set of drawing scales. For future service, everything depends on a proper choice in their purchase, more particularly if their use is to be continuous; and as we assume throughout these articles that the student has little, if any, previous knowledge of the subject, it is especially necessary that he should know what constitutes a good serviceable instrument, as the possession of inferior ones will be a constant source of annoyance to him.

In giving the characteristics of a *good* instrument, it is of the first importance to understand the use to which it is applied. With draughtsmen, a pair of *compasses* and a pair of *dividers* serve two very different purposes, and are therefore differently constructed, but their names and uses are often misunderstood. "Compasses" are never used for dividing, nor are "dividers" applicable to compass work. Beginners should therefore note that the former are specially intended for putting in circular lines in pencil or ink, and that the proper and only use of the latter is the division or measuring off of lines and spaces. These separate and distinct purposes give at once a clue to their proper form and construction. They are both instruments with two movable legs, jointed together by a forked end, and secured by a pin and washer, as shown in Figs. 8 and 9 at AA. The compasses, however, being used to draw circular lines, or lines described about a point everywhere equidistant from it, should have jointed legs, one with a knee joint at B, and the other with a socket, as at C, to enable it to be easily removed and replaced by the ink or pencil points D, E when required. The purpose of the knee joints shown at B in the compasses, and *b b* in the pen and pencil points, is to enable the lower parts attached to them to be adjusted perpendicular to the surface of the paper, in order to obtain a truly circular line, and to allow both nibs of the inking point to bear fairly upon it.

Dividers, which are not necessary to the student for some time forward in his study, should have legs of equal length, but without joints, as in Fig. 9, their lower parts being made of steel of triangular section to within ⅝in. of the ends, which should be gradually worked off into nicely

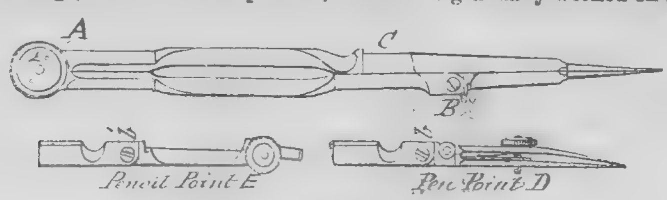


Fig. 8.

rounded points, as shown. This latter feature is one that should obtain in the points of compasses, bows, etc. *Triangular* pointed instruments should never be used, as their points act the part of a rimer, cutting their way through the paper into the drawing board, making unsightly holes, and causing them to describe anything but true circles.

Pen and pencil bows are compasses

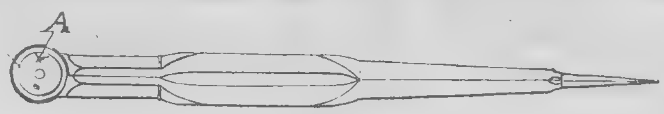


Fig. 9.

intended for putting in smaller circles and circular arcs. Single-jointed ones, such as are shown in Fig. 10, will serve all the present wants of the student, if well made. The socket in the pencil bow should be tubular, and of a size to take leads, and not lead pencils. As these two instruments will be much oftener used than any other, it is advisable that the student should supply himself with the best to be afforded, as they will amply repay any present outlay.

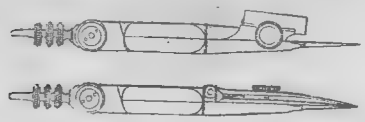


Fig. 10.

In selecting the foregoing instruments, care should be taken that they are all sector jointed with double leaves and well made; there should be no shake or slackness in any of them, and they should be equally stiff in the joints at any point from being full open to closing. The test for a pair of compasses is to open out their legs well apart and then to fold each lower half leg together; if the points meet each other truly they are correct in the joint; if they cross one another, the joints are not properly made.

Drawing or ruling pens are of two kinds—viz., those made with a jointed nib, as in Fig. 11, and those without a joint. The

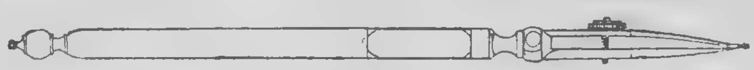


Fig. 11.

former, though more expensive, is to be preferred, on account of the facility for cleaning and sharpening; but the latter is a very serviceable pen, if well made and finished. It will be observed in the sketch that the under or fixed nib is much straighter and thicker than the hinged one; this is so made to resist the pressure of the hand upon it when drawn along the edge of the tee or set squares. In all ordinary pens the nibs are of equal thickness, and the hand-pressure tends to close them and prevent the flow of the ink; but by providing a stout springless inner nib this tendency is overcome. The stem or handle of this pen, it will be noticed, is squared, to indicate how it should be held by the fingers when in use.

The drawing scales recommended for present use by the student are a set of three lately introduced by Messrs. Jackson Bros., of Leeds, made of pliable varnished beech, and giving twelve scales of the standard units of measurement generally used in engineering drawing. They are decidedly to be preferred to any cardboard scale, as the dividing is well done and there is no tendency to double up or get dirty by use. When the student acquires a more perfect knowledge of the use of instruments and scales, he can add to his stock already in possession whatever is necessary, always bearing in mind that a good tool in the hands of one who knows how to use it will invariably do better work, and is to be preferred to one of inferior quality; in the meantime, those herein recommended are all-sufficient for present requirements.

(To be continued.)

Circulation in Water-tube Boilers.

(Concluded from page 38.)

If the sketch were modified a little, and the several tubes united into one large cylindrical body, as at D in Fig. 4 (page 37) and exposed to the action of a fire underneath, nobody will doubt that the circulation would be as indicated by the arrows.

The upper cylindrical drum, which is always about one-half filled with water, is in reality a tube connecting the two water legs; and in this drum or tube the direction of the circulating stream is just opposite to the direction of the stream in the bottom rows. Now if a tube should be inserted directly under the drum, the stream in the tube would have the same direction as in the upper drum. And if the whole space between the drum and the upper row of tubes should also be filled with such tubes, it is clear that in part of the tubes the circulation would be one way, in the other part the other way.

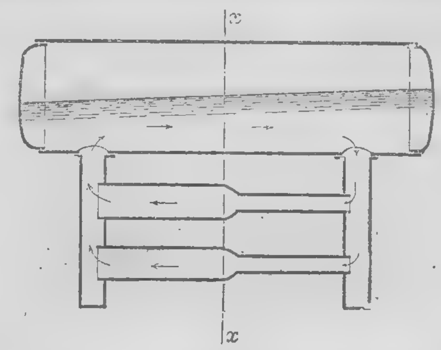


Fig. 6.

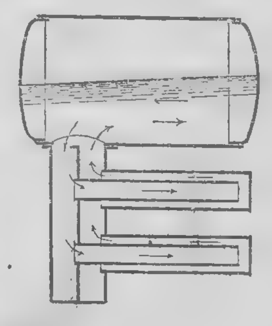


Fig. 7.

The flow of water from the rear water leg and through the tubes to the front or rising leg and back through the drum is only caused by the difference in specific weight of the contents of the two legs. The resulting phenomenon is the same as that of the flow of water from a reservoir and a descending tube into the air.

If such a reservoir (Fig. 5) has a descending tube of the same width throughout, the water flows at a rate of $v = \sqrt{2\,g\,h}$ feet per second, if h is the total head. But if a hole should be drilled in the tube, say at a, no water would issue there. On the contrary, air would be drawn in, and the same thing would occur at any hole which might be drilled farther up the tube. If now the extremity of the tube be partly closed, so that there is pressure in the tube, then water will flow out from the several orifices; but if the total area of the openings be larger than the area of the tube, air will be drawn in at the higher ones.

In this manner the exact height of the row in which the return of the stream takes places can be determined. It is in that horizontal section through the water leg in which the total area of the lower rows of tubes becomes larger than its own.

I may mention here that I had several models made with tubes of glass, which could be heated by a spirit lamp, and have spent many hours in studying the interesting phenomena of circulation, which in every respect confirmed the views given above.

These considerations may be applied to every type of water-tube boiler, whether it is of the double-leg, single-leg, or sectional type. It may be easily shown that there is no radical difference between water-tube boilers with two legs and those with only one. Fig. 6 shows a water-tube boiler with two water legs, and tubes of smaller diameter at the rear end. The desired circulation is indicated by arrows. If this figure were drawn on tracing paper and folded over on the line x, x, Fig. 7 would result. The smaller ends of the tubes in Fig. 7 are now the inner tubes, and the water leg has a partition wall to

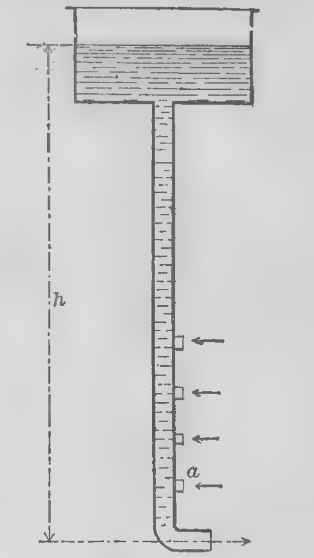


Fig. 5.

separate the rising from the descending stream. The streams do not disturb each other, the arrows being of the same direction in every separate part of the boiler with the exception of the upper drum, where the arrows show opposite directions. In practice, therefore, the steam drum should be separated into two parts, one communicating with the front and the other with the rear part of the single water chamber. This may be done by a partition plate or by a large tube extending from one end in communication with the chamber to the other end of the drum, or two separate drums may be provided. But the condition of dividing the upper drum into two parts cannot be dispensed with. This separation is peculiar to the type of boilers described, but of course has nothing of special merit. Another and very important peculiarity of the tube boilers with one water leg only, is that the area of steam and water spaces in the tubes is only one-half that in the tubes of boilers with two legs if the same size of heating tubes has been chosen for both.

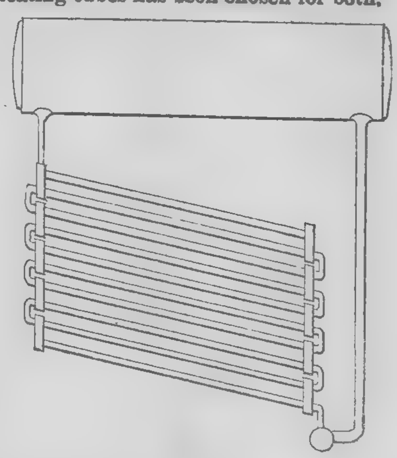


Fig. 8.

Finally, sectional boilers are to be considered. Those of the type shown in Fig. 8 consist of an upper steam drum and a group of tubes. The tubes are connected endways by heads which cover two or four tubes, and the heads communicate by caps. From the upper heads as many tubes lead to the steam drum as there are heads in one row. The bottom heads are connected to a tube which is in communication with the upper drum. The circulation in the tubes of this boiler is the same as in other boilers

with narrow connections to the steam drum; in the bottom tubes the water rises towards the steam side, while it descends or flows back through the upper rows, part of it going through the upper shell. With a boiler of this kind, of Belgian manufacture, the following accident occurred while being submitted to an evaporative trial. During the test the water suddenly began to fall and wholly disappeared from the glass, though the boiler was not leaky at all. The feed pump was applied, but it took much time before the water reappeared. Then it rose so quickly that it went quite over the glass and filled nearly the whole boiler. This remarkable trick—which of course made the continuation of the trial impossible--occurred several times. It is not difficult to find the cause. The passage for water and steam through the many caps and heads is much impeded and offers a great resistance. If the boiler is regularly steaming, then a current circulates through the tubes and the upper drum. Now if cold water is introduced, this water drops like lead to the bottom tubes, which immediately cease steaming. Now the current circulates only in the upper rows of tubes and the drum. The few steam bubbles which are formed in the bottom tubes stick fast at any of the obstructions and have no opportunity to join in the circulating stream. If a sudden cooling takes place, caused perhaps by opening the firedoors, the steam bubbles condense and the water drops from the drum. The same thing occurs once more if the feed pump is again started, till at last the sudden generation of large bubbles throws the water back to the drum.

If I should now set forth in precise and distinct words the result of my investigations I would say:—A regular, intense, and equally-directed circulation in all the tubes of a water-tube boiler can only be secured if (highest rate of evaporation assumed) the area of the water legs and connections to the steam drum are nowhere smaller than two-thirds of the total tube area. For common rates of evaporation the equally-directed flow in the tubes can only be secured if the total tube area is smaller than any of the passages for the circulating current in the system.

Wrought Iron.

THE second of a series of lectures on "Wrought Iron" was delivered on the 2nd inst., at Mason College, Birmingham, by Mr. T. Turner, in the Chemistry Theatre. The lecturer remarked that the indirect method of producing wrought iron was now almost universally employed, and for this purpose cast iron was first smelted in the blast furnace. Great improvements have been introduced in blast-furnace working during the last decade, but chiefly in connection with the production of iron for steel making and foundry purposes. The iron used for puddling is generally of a special character, being close-grained or "strong" in character, and is known as "forge" pig. This is usually produced in furnaces having a moderate production, though there is no reason why the production per furnace should not be increased, and still manufacture forge pig. One advantage of the puddling process, as compared with either of the great methods of steel making, lies in the fact that iron of very diverse composition can be treated by the puddler, while a special iron of definite composition is necessary in order to give a good result in steel-making. No doubt this is one reason why the iron trade has so long retained the supremacy in the Midland Counties. Though under serious disadvantages in regard to cost of transit to the sea coast, the district has, on the other hand, the advantage of easy access to a number of districts which produce pig iron unsuitable for steel making. This not only ensures a tolerably steady supply of crude material, with only moderate fluctuations of price, but also allows the ironmaster, by suitable mixture of different brands, to obtain a better result than when a single kind of iron is used. The element phosphorus, when present in large quantities, renders pig iron of little value for puddling, and the price of the original pig iron is perhaps more dependent on the proportion of phosphorus than on any other single constituent. The hematites of Cumberland or those produced from imported Spanish ore are the purest in this respect, and generally contain only 0·04 per cent. of phosphorus, while those from the Forest of Dean contain about 0·07, all-mine South Staffordshire about 0·55, Lincolnshire and Derbyshire 1·2, Northamptonshire 1·5, Cleveland 1·6, and cinder pig up to 5·5 per cent. The proportion of phosphorus is usually fairly constant in pigs from the same locality, but the silicon, on the other hand, varies from day to day. As a rule the pig iron made from the Northampton ore is more silicious than that from other Midland ores; while at the same time the sulphur and manganese are both very low. Sometimes manganese is sought after for puddling purposes, and most manganese is found in North Staffordshire pigs, while cinder iron often contains two or more per cent. of manganese, which partly counteracts the injurious effects of its other elements. Sulphur is a very objectionable element when present in cast iron, and recently several new processes have been introduced to get rid of it. Fortunately, in the Midlands, the iron manufacturer is seldom troubled with sulphur in his bars, so that there is less need for special treatment here than in steel-making districts. The success of the subsequent processes depends to a large extent on the proper selection of the cast iron to be treated, and the manufacturers of the district who possess the necessary knowledge are on account of their situation in a particularly favourable position for obtaining a good selection of pig iron for making suitable mixtures. Some years ago chemical analysis, though common in steelworks, was almost unknown in forges; but every year advantage is being taken of scientific knowledge to a greater extent, and now many of the local ironworks have on their establishments men with the necessary skill for performing analysis, and the result has been, in a number of cases, considerable economy in the cost of production.

Shipbuilding Notes.

The new American harbour defence ram "Katahdin" was launched on the 4th inst. at Bath, Maine, U.S.A. This vessel, which has been designed on a novel principle by Admiral Ammon, has as her sole offensive force her ability to "ram" an enemy. Her dimensions are:—251ft. long, 42½ft. beam, 23ft. deep amidships, 15ft. draught, and a tonnage of 2155.

The s.s. "Hogarth," which was launched from the shipbuilding yard of Messrs. Hall, Russell and Co., Aberdeen, about two months ago, went on her trial trip on the 31st ult. The vessel, which is 262ft. in length, with 33ft. breadth of beam, is fitted with triple-expansion engines, having cylinders 26in., 43in., and 70in., by 42in. stroke, capable of indicating over 2000H.P.

A large steel screw steam tug was launched on the 1st inst., from the yard of Messrs. Cox and Co., of Falmouth. The dimensions are:—Length, 120ft.; beam, 30ft.; and depth, 11ft. 8in. She will be fitted by the builders with triple-expansion engines, having cylinders 15in., 23in., and 38in. in diameter, by 25in. stroke. Steam will be supplied from a large boiler at a working pressure of 150lb. per square inch.

On the 2nd inst. the s.s. "Georgios Michalinos" left the Cleveland Dockyard of Sir Raylton Dixon and Co., Middlesbrough, for her official trial trip. Her principal dimensions are:—Length over all, 335ft. 6in.; beam, 42ft.; depth moulded, 22ft. 9in.; and she has a deadweight carrying capacity of about 4500 tons. The engines have been fitted by Mr. John Dickinson, of Sunderland, the size of the cylinders being 24in., 39in., and 64in. diameter, by 42in. stroke. Everything worked satisfactorily during the trial.

The "Ferguslie," a screw steamer of 500 tons deadweight, engined by Messrs. Bow, M'Lachlan and Co., Paisley, and which was launched a few days ago from the yard of Messrs. J. M'Arthur and Co., Paisley, went on her trial trip on the 31st ult. The weather was unfavourable for a trial trip, but despite the stormy and boisterous day, a speed of 11·416 knots was maintained on the measured mile, a result which, with the excellent behaviour of the steamer throughout the day, gave the utmost satisfaction to the owners and contractors.

On the 1st inst. Messrs. John Blumer and Co., Roker, launched from their yard the steel screw steamer "Sibun," which is built to the order of the Sibun Steamship Company Limited. The principal dimensions are as follow:—Length, 260ft.; breadth, 37ft.; depth, 19ft. The engines and boilers are being constructed by Messrs. G. Clark Limited, Southwick. The diameters of cylinders are 22in., 36in., and 59in., with a stroke of 36in. The boilers are of steel, with a working pressure of 160lb. per sq. in.

The s.s. "Turret," the first example of a new type of cargo steamer built by Messrs. W. Doxford and Sons Limited, left the Wear for trial on the 28th ult. After adjusting compasses, the engines were run full speed, when everything proved most satisfactory. The builders were congratulated on the success of their scheme, as the distribution of the weights had led to the most marked improvement over the ordinary methods of ballasting and bunkering. Among the improvements in this vessel should be mentioned the ash discharging arrangement, which is on See's principle, the ashes being discharged direct from the stokehole by the ballast pump, thus dispensing with all the usual troublesome hoisting up to the deck. The arrangement also obviates the usual nuisance of having the ashes carried across the deck.

The Selection and Treatment of Steel for Forgings.

AT the last ordinary meeting of the Leeds Association of Engineers, the president (Mr. Robert Lupton) in the chair, a paper was read by Mr. Francis Rixson, of Sheffield, on "The Selection and Treatment of Steel for Forgings." Mr. Rixson said: Before the invention of the Bessemer process of making steel, and for some time after, until confidence in that material was established, fagotted iron was the only material available for engine and machine forgings; and notwithstanding its tendency to establish seams and evident laminations it served its purpose admirably, and even now, in the presence of mild steels of the highest excellence—an excellence far beyond the hopes of their several inventors—it continues to hold its own. For all difficult shapes (where steel castings are not permissible) and where piecing up after partial machining is necessary, and further, where "case-hardening" is called for, a good iron is essential and will hold the field in its proper sphere.

Then, for the screw shafts of steamers, and for piston rods for steam hammers, iron lasts longer than steel, unless the latter is oil-tempered before using. An iron rod in one of our hammers was in constant use over 13 years, and even now is good, although only kept as a duplicate. I never heard of a steel rod of half that age; it will probably have made 7000 tons of steel forgings up to its replacement, and I am pleased to be able to speak a good word for iron.

Still, there are many purposes for which steel, carefully selected and judiciously adapted to the duty to be done, presents such features of excellence as no other known substance commercially available at a reasonable price can be said to possess. Its uniform texture; its freedom from seams and impurities; its wearing properties, and the ease by which it can be tooled and polished, marks it out as the ideal metal for the moving parts of both heavy and light machinery.

There are several methods of making mild and other steels for mechanical and kindred purposes (and I purpose to-night to refrain from mentioning the crucible process, that subject having already been skilfully discussed in this room by able exponents of its merits), but for high-class work, engineers and technical experts generally agree that the Siemens process is the one most reliable. Its earlier sister process, the Bessemer method—for which the world owes much, not only to Sir Henry Bessemer, but also to Mushet, Heath, and other workers, whose names do not often appear in the light they deserve—is also a valuable process. Where quantity is the first consideration the Bessemer process is vastly superior, but where nice gradations of temper and quality are imperative, the Siemens is indispensable, as frequent tests can be taken and variations made in the composition until the exact point is reached which the specification being worked to calls for. There is also the more recently developed basic process, both in Siemens' and Bessemer's practice, but as those yield a class of material for constructive aud commoner purposes, they do not fall within the scope of these remarks.

The steel best adapted for forgings, such as piston rods of engines, main engine shafts, marine cranks, and other parts subject to severe torsional strains and carrying heavy loads, should be of such a nature as to give a tensile stress of 27 to 30 tons per square inch, with a high percentage of elongation (say 35 per cent. in 2in.), and a reduction of area of say 45 to 55 per cent. A bending test 1in. square, 10in. long, should bear bending over a round bar 1½in. diameter, and it should bear closing thus ⊂, and show no sign of fracture. For special cranks for high-speed engines a steel of higher tensile strength is desirable, and 34 tons tensile, 28 per cent. elongation and 52 per cent. reduction, gives excellent results, especially when used in white metal bearings, as it never licks up the metal.

It is not necessary to define the chemical composition of an ideal forge steel, as good results can be, and are, produced by different methods; but I prefer a stiff steel of good quality to a soft steel of low character, and I always question the judgment of engineers who stipulate that their forgings should be made of steel under 0·015 carbon. My own opinion is, that about 0·030 is better in every way, and is certainly more free from blemishes than the softer grades of material. Perhaps the best proof of this is to be found in the punishment or fatigue test, described at the end of this paper, a test which leaves no doubt of the capacity of the material to resist such shocks as may be expected in use.

Take also an example of the falling test, one on which public engineers rely almost as much as on the tensile test. Select a forged steel bar, say 3½in. diameter and 5ft. long, place it on supports 3ft. apart, drop a tup of 1120lb. on it from a height of 20ft., continue the blows until an angle of 90° is reached, then press the ends towards each other until the curve ⊂ is reached without fracture.

A railway axle of the usual shape, 4½in. diameter in the middle, bore six blows each of 20ft. drop from a tup of 1650lb. without breaking, and a further blow of 38ft. drop broke it. Another axle 4½in. diameter bore six blows of 20ft. and 11 blows of 40ft. without breaking; after the seventeenth blow it was cooled in ice and snow (it being warm from concussion). It then broke at the eighteenth blow, and no wonder.

An iron axle was next tested, 4⅝in. diameter. The test specified was six blows from 25ft.; it broke at the fourth blow, showing a coarse dirty fracture. A steel axle of the same size bore six blows of 25ft., and also twenty blows at 40ft. These particulars show the wonderful tenacity of a good steel forging; and when it is remembered that good steel is cheaper than good iron, the difference in strength, as an equivalent of money, is the more remarkable.

It has been stated that iron and steel are liable to "tire" and become flaky or granular. The late Mr. Robert Hadfield once showed me a bar of iron which had been subject to some thousands of sharp blows; a piece was easily broken from the 1½ round bar by a hand hammer. The flakes were something like the scales of a roach; the other piece of the bar had been reheated and thrown down to cool, and its fracture was fibrous, like an ordinary piece of new iron. I made a note of this, and recommend that forge chains and porter bars be frequently warmed so as to "rest" them.

In speaking of material, I may say that Siemens steel is now being made from 0·09 carbon up to 1·50 per cent. The latter is used for fine files, with great success, whilst tempers of 0·075 to 0·095 make wonderfully good saws and springs; indeed, so successful has this become that common crucible steel is a thing of the past.

I have endeavoured to describe the nature and quality of the material for forgings, and now a word as to treatment. Much depends upon the manner in which the heating or furnacing is carried on. The heating should never be rapid; time should always be given for thorough soaking through, or wasters are a certainty; and you all know how disappointing it is, sometimes disastrous, to find days, and sometimes weeks, of turning are lost by a flaw appearing just when the job is apparently done.

Hammering should never be too rash at first; it segregates the particles and weakens the piece. On the other hand, I disapprove of cold hammering as tending to brittleness.

Steel so treated needs to be annealed, as also should all forgings made in bosses or dies to exact shapes, or else, when at work, they are liable to expand, and abrade their bearings.

A great failing in engineers is that in their drawings they often show sharp sets in steel shafts, etc., where it is possible these should be avoided, as sharp corners weaken a shaft materially. Draughtsmen are often sinners in this respect.

Simplicity of design is of great importance. I remember a case where, in a set of pumping engines of given size, there was a difference of design which meant £110 on the set of forgings, and carried the order with it. Clumsiness in design can almost be excused in old engines, but in the present day there is no excuse for either clumsiness or ugliness.

(To be continued.)

The Institution of Mechanical Engineers.

IT was a large assembly of members that met on Thursday and Friday last, at the 46th annual general meeting of the Institution of Mechanical Engineers, under the chairmanship of Dr. William Anderson, F.R.S., the president. As showing the growth of the institution, it was mentioned in the annual report of the council that at the end of last year the number of names in all classes on the roll of the institution was 2147, as compared with 2077 at the end of the previous year. Other formalities, including alterations in the articles of association and bye-laws, were proceeded with, after which the two papers referred to in a previous issue were read. The first paper, by Mr. E. Froude, which dealt with

the experimental apparatus and shaping machine for ship models at the Admiralty Experiment Works at Haslar, would probably be difficult to understand without the aid of drawings. The establishment at Haslar, which has supplanted that formerly in operation at Torquay, comprises as its essential feature a long covered waterway, in which models of vessels are towed to ascertain their resistance. This, then, is the object of the works, and to a large extent our war vessels are constructed from designs made according to the tests made in that canal; in fact, the tests are conducted with such accuracy that the ships built from the designs correspond very closely indeed with the results of the experiments. It is in that waterway that the models, generally about 14ft. long, and made of hard paraffin, are tested. They are towed from a dynamometer carriage by a stationary engine, the carriage running on a railway of 21ft. gauge, arranged on the tops of the side walls of the waterway. The shaping of the models is effected by cutting a series of grooves in it at the successive levels of the series of water lines in the half-breadth plan. This is accomplished by a pair of revolving cutters, between which the model passes, travelling in a fore and aft line, while the cutters are moved laterally, receding from and approaching each other symmetrically in such accordance with the longitudinal travel of the model as to trace in plan upon it the intended horizontal section or water line. This due accordance of the lateral motion of the cutters with the longitudinal motion of the model is effected by the operator so regulating the cutter motion as to maintain a tracer in contact with the corresponding water line on the drawing. By suitable mechanism the drawing itself is made to imitate the longitudinal travel of the model, whilst the tracer imitates the lateral travel of the cutters. The discussion on the paper was practically *nil*, two or three speakers expressing regret that the paper was not more ample, and that details as to the results of tests were not set forth. This was, however, considered by the author to be beyond his province. Mr. White, director of naval construction to the Admiralty, mentioned that the Haslar establishment had proved of immense benefit and economy to the country in the design and advancement of the speed of warships, and that Italy had erected similar works at Spezzia, and that the Russian and United States Governments were about to erect such establishments. With regard to the second paper, which was a description by Mr. William Matthews of the Southampton waterworks, the principal features of interest seemed to be the use of beam engines, working at low-pressure, and the type of filters employed. The boilers supply steam at 60lb., and some speakers in the discussion expressed surprise at this low pressure. As the author stated in reply, those who had had to deal with pumping water for many years appreciated that slow-moving engines with a long stroke were much better for the purpose than fast-running engines, and in order to emphasise this he stated that not a penny had been expended upon repairs during the 3½ years that the engines had been in operation. The filtering material in the filter consists of cotton cloth mounted upon zinc, and which intercepts the deposit of bicarbonate of lime in the water, which is removed as occasion arises. On the whole the meeting was not of such interest as that held in August last.

Smelting Processes for the Extraction of Silver and Gold Ores.

At the ordinary meeting of the Institution of Civil Engineers on Tuesday, the 31st January, Mr. Harrison Hayter, president, in the chair, two papers were read, dealing with the extraction of the precious metals from their ores by smelting.

The first paper was on "Smelting Processes for the Extraction of Silver and Gold from their Ores," by Mr. Henry F. Collins, A.R.S.M., Assoc. M. Inst. C.E. This paper contained a description of modern American smelting practice, the principles of which, derived originally from the Freidberg and the Harz districts of Germany, had been modified in detail in America, on account of the abundance and richness of the ore deposits there and the high price of labour. The opening-up of the Leadville carbonate deposits was the immediate cause of improvements being made in water-jacketed furnaces. The European specialised processes for different kinds of ore were contrasted with the uniform treatment of all ores in America.

Methods of extracting the precious metals were classified broadly according to the agent by which the extraction was effected. In lead smelting, great economy and regularity in working had been secured by an increase in dimensions of the furnaces employed, from 7sq. ft. to 35sq. ft. in sectional area at the tuyères.

Cast-iron jackets in small sections had proved more convenient and economical in maintenance than wrought iron jackets in large sections. Consideration was given to the different modes of charging the furnaces, whether at the side or the top, the latter being the almost universal practice. The details of the construction of a water-jacketed furnace were next discussed. The escape of lead fumes at the throat had been much diminished by telescoping hoods and cover plates, and had been prevented altogether by the adoption of charging thimbles. The question of fuel was next dealt with; charcoal being almost invariably used along with coke in order to increase the furnace capacity. Outside wells for furnaces had been abandoned; though outside "fore-hearths" or "settlers" had proved successful in separating slag from matt, and were coming into general use. The method of separating slag and matt without "settlers" was described; also the condensation of fumes and the treatment of flue dust to prepare it for resmelting.

The chief difficulties which had to be met by smelters at the present time were:—(1.) The fineness of the ores offered, resulting in a decrease of furnace capacity and increased loss in slags. (2.) The replacement of fusible carbonates by refractory sulphides, which had to be calcined. The form of furnace usually adopted for this purpose was the long reverberatory calciner, often with a fusing hearth attached to it. (3.) The large amounts of silicious and other refractory ores offered for treatment, and the scarcity of lead ores. Owing to this latter feature, great attention had been paid to the composition of both the charges and the slags, in order to effect economical extraction of the ore. The old German litharge process had been abandoned as wasteful and was scarcely to be recommended under any circumstances. (4.) The great quantity of zinc in most sulphide ores and the attendant difficulties in furnace manipulation. "Pastiness" of slag and matt, due to the presence of zinc, caused slags to be "foul." The proper composition for slag; the classification and mixture of different kinds of ore; the fundamental combinations of slag constituents, and the calculation of charges, were then elaborately treated.

The paper proceeded to give a description of a typical "custom" smelting works on the lead basis, situated at El Paso, Texas, including the modes of weighing and sampling ores, the arrangement of the mixture bins, the cost of fuel, fluxes, etc. Particulars were afforded of the calcining furnaces for matt and concentrates, and of the engines, blowers, pumps, and other plant; and attention was drawn to the special advantages enjoyed by these works over others, owing to the large tonnage of Mexican carbonate ores received there.

Allusion was made to the smelting works at Las Trojes, Michoacan, Mexico, described fully in the second paper, and a comparison was instituted between these works, which deal with ore from the company's own mines, and the former, and the cost of smelting at both places was contrasted. The process of concentration through the agency of metallic copper, its advantages and disadvantages, and the limitation of its applicability to certain classes of ore, were next dealt with, followed by a description of a smelting plant at Torreon, Mexico, which had been employed by the author for smelting ores poorer in copper than any hitherto smelted to metal at one operation. The ores mined yielded the copper base, in addition to a small quantity of silver and gold, while custom-ores were bought only to raise the precious metal contents of the bullion. The details of working and the results obtained were stated, and experiments on the production of rich bullion with a high rate of concentration were described.

A comparison of the cost of smelting at Torreon with the costs at El Paso and at Las Trojes showed that the work at the first-mentioned place was economically conducted, in spite of its small scale. The right principle to adopt in treating such ores would appear to be to use matt, and not lead, as the agent of extraction in the first instance.

The second paper gave an account of "The Erection of Silver-lead Smelting Works in Mexico," by Mr. J. W. Malcolmson, A.R.S.M., Wh. Sc., Assoc. M. Inst. C.E., describing the design and erection of a large plant, capable of treating 100 tons of ore per day, at Las Trojes, in the state of Michoacan, Mexico, for the Michoacan Railway and Mining Company Limited, of London.

A slag-dump from the existing works was utilised as a charging floor, and the furnaces were erected at a lower level, upon which were also placed the machinery, engines, etc. The furnaces, which were water-jacketed, were 36in. by 84in. at the tuyères, and 12ft. 6in. from the tuyères to the charging floor. They had each ten 3in. tuyères, five a-side, facing each other; the water jackets were of wrought iron, with a 6in. water space between the fore and back plates. Air was supplied to the furnaces at a pressure of 10oz. per square inch from the blowers in the machinery building. The furnace was built of fire-brick to the charging floor, and above that level of common red brick. A 3ft. wrought-iron downtake, leading to a main flue, was provided to carry off the dust and fume. In the machine shed a 6ft. Pelton wheel was attached directly to the centre of the 4in. main shaft, and supplied with water from a tank situated 487ft. above the works through a 12in. wrought-iron pipe. The wheel made 270 revolutions per minute. The blowers were of the Baker type, discharging 30 cubic feet of air per revolution. All air mains were above ground. Ventilation of smelting works seldom received much attention in Mexico, but if proper regard were paid to it, much sickness and discomfort might be prevented.

City Improvements.

The City Commission of Sewers, or rather the present commission, has met for the last time, but during its existence some good work has been accomplished. Apart from the improvements made in the widening of thoroughfares, an important concession has been obtained from the promoters of the Central London Electric Railway, the Bill authorising the construction of which has received the Royal assent. An underground station with subway approaches is to be erected opposite the Mansion House, and access to the station will be by two staircases formed in the footway in front of the Royal Exchange, and also by six others immediately near. Connected with the staircases will be subways which will enable not only railway passengers to get to and from the station, but the public generally will also be permitted to cross beneath the roadway at that point, which is probably the most dangerous crossing in the metropolis. With regard to electric lighting, the contracts entered into by the Commission are now practically finished, and the illumination of the main streets by arc lamps is virtually completed. The lighting of the side streets with glow lamps is now being commenced, but private illumination is in a backward condition. This state of affairs will, however, soon be altered. New plant has been laid down at the Bankside station capable of supplying about 8000 8C.P. lamps, and this will in the course of a few weeks be set in operation.

Catalogues, Price Lists, Etc.

Engineers, Tool Makers, Metal Merchants and others are invited to forward Catalogues, Pamphlets, Circulars, Price Lists, etc., for notice in this column.

From the Keighley Engineering Company, Waddington-street, Keighley, we have received a combined calendar and price list of lathes, of which this firm make a speciality. The list gives full dimensions, weights, and prices of a large variety of lathes suitable for heavy work and for ordinary requirements. We understand that the firm have laid down a special plant for the sole manufacture of these tools, this including a large amount of machinery specially designed for high-class machine-tool making.

From the Globe Engineering Company Limited, 38, Victoria Buildings, Manchester, we have received an exceptionally neat circular, descriptive of the "Globe" automatic engine, and illustrating a few of its many applications. Full particulars, dimensions, etc., of the engine are given, as are also some very pertinent remarks on the advantages of sub-divided power, which deserve the careful consideration of all power-users and manufacturers.

Mr. Henry F. Cockill, Mount View Leather Works, Cleckheaton, has sent us a copy of his catalogue of machine belting. Several illustrations of the various machines used in the preparation of leather belting are given; also methods of joining belts, prices of various kinds of belting, leather ropes, etc. From the same firm we have also to acknowledge the receipt of a very effective calendar.

Mr. W. Archibald Briggs, East Dock-street, Dundee, has sent us a tastefully-printed circular, containing particulars of and directions for using Richards's patent aluminium solder. Mr. Richards appears to have successfully solved the problem of aluminium soldering, his solder being used by many leading firms in the United States.

From the Bowling Iron Company, Bradford, we have received a very useful calendar of the perpetual type. Several illustrations of this firm's specialities are grouped together in the centre of the sheet with very good effect.

Mr. Thos. R Ellin, Footprint Works, Sheffield, has just issued a new list of English-made cycle tools. Two of the shafting spanners illustrated are new patterns introduced this year.

Trade Notes.

The Anderston Foundry Company, Glasgow, have secured an order for 4000 tons of sleepers for India.

Messrs. Galloways Limited, Manchester, have completed the first pair of engines for the Manchester Corporation electrical plant.

The directors of the Sheepbridge Coal and Iron Company have declared an interim dividend at the rate of 5 per cent. on all classes of shares.

The Austrian Small Arms Factory, at Steyr, has contracted with the Roumanian Government for the supply of 100,000 rifles and 20,000 carbines.

It is stated that an offer of £10,000 was recently made for the Gospel Oak Ironworks, Tipton, Staffordshire, and was refused. These works have been in the market for some time.

The directors of the Consett Iron Company have resolved to pay an interim dividend of 6s. per share on the ordinary shares, and of 3s. per share on the 8 per cent. preference shares.

Messrs. Yates and Thom, engineers, Blackburn, have received an order from the Portsmouth Town Council for the boilers and engines required for their electric-lighting scheme.

The Antwerp Hydro-Electric Company have concluded arrangements with the German-Austrian Mannesmann Tube Works for the supply of seamless tubes for the high-pressure system in Antwerp.

Out of 85,000 houses in Paris 20,000 only are lighted by gas; in 1891 the sale of gas amounted to 283,000,000 cubic metres. The total number of incandescent lamps now in use is given at 175,000.

The Airdrie Iron Company have made a contract with the Glasgow Corporation for a set of large condensers at their Dawsholm Gasworks, similar to those supplied by them for the same works in 1891.

The contract for the turbines in connection with the generating plant for the electric tramway at Niagara Falls, Ontario, has been secured by Messrs. Wm. Kennedy and Sons, Owen Sound, Ontario.

The directors of Henry Bessemer and Co. Limited announce a dividend for the past year of 17½ per cent. They give an unfavourable opinion as to trade for the current year, stating that work at present is very scarce and prices low.

Messrs. William Allan and Co., of the Scotia Engine Works, Sunderland, contemplate an important extension to their premises in the Low-street, close to the river Wear. The extension will take the shape of a large foundry, which will be about 160ft. long by 60ft. broad.

Messrs. J. and W. Weems, Johnstone, Scotland, have constructed and delivered to a well-known electric manufacturing firm, for covering electric and telephone cables from ⅛in. to 3in. diameter, in continuous lengths and any desired thickness of lead, one hydraulic press 33in. diameter, cylinder, and ram.

The directors of the Rhymney Iron Company Limited announce that they are not in a position to pay an interim dividend. Their decision in March, 1890, to discontinue their steel manufacture, has been abundantly justified, as any attempt to keep the furnaces, Bessemer plant, and rolling mills longer in operation could only have been attended with serious loss.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 391, Strand, London, or New Bridge-street, Manchester.

Wheel cutter in metal only. Every description of gearing. R. Chidlaw, 43, City-road Manchester.

Having regard to the enormous circulation of The Mechanical World, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one half-penny per word. The Editor will be glad if Mechanical World readers will kindly bear this in mind as occasion arises.

Improved Milling Machines.

THE illustrations given herewith show two forms of improved milling machines placed upon the market by Mr. Charles Taylor, Bartholomew-street, Birmingham. Fig. 1 is a horizontal spindle machine, designed for ordinary milling, and furnished with a spindle of large diameter, driven by a cone pulley suitable for a 3½in. belt. The maker claims that better finished work is produced by the direct-driving arrangement than by a geared machine. The largest diameter of speed cone is 13½in., while the countershaft is fitted with two pairs of fast and loose pulleys giving eight changes of speed and ten changes of feed. On each side of the front bearing steel friction rings are provided to receive end pressure.

The upper part of the body of the machine is of an arched form and rigidly connects the two spindle bearings together. It is bored out to receive the cylindrical steady arm, which is of large diameter, and is held in position first by a bolt, as shown, causing the casting (one side of which is slotted) to grip the arm, and, second, by a ⅝in. rod passing from the front of the arm to the back of the machine. This combination forms a most solid connection, and at the same time allows the arm to be readily detached from the machine. This machine is made in three sizes.

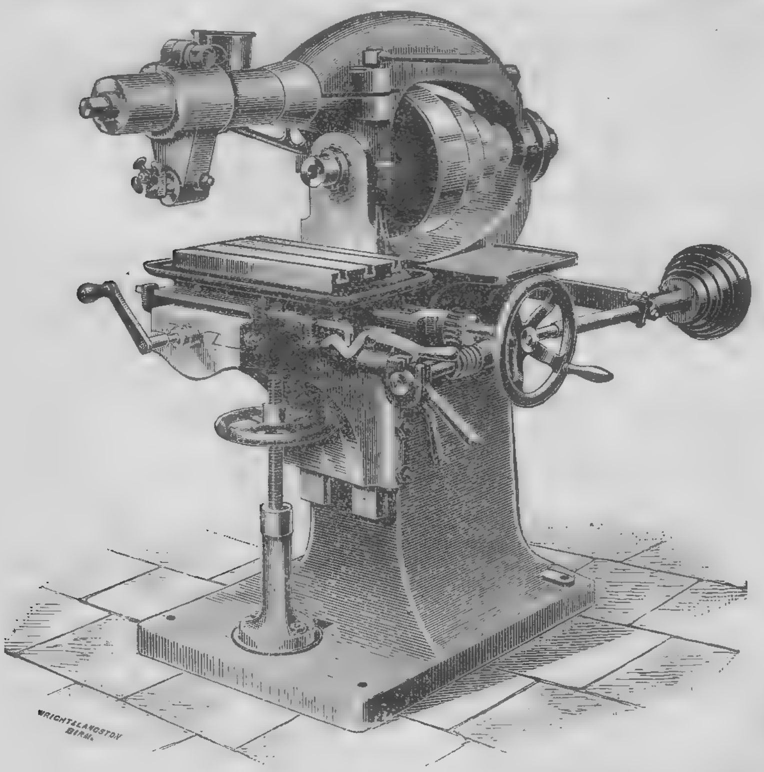


Fig. 1.

IMPROVED MILLING MACHINES.

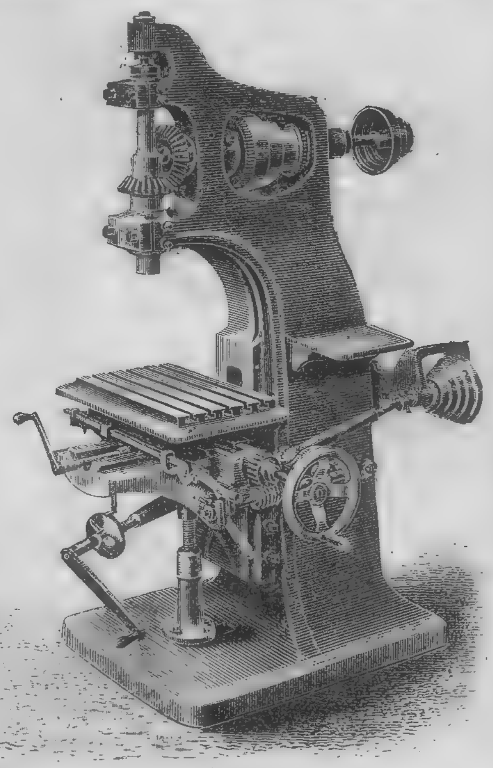


Fig. 2.

Fig. 2 represents a handy form of vertical milling machine also suitable for boring, drilling, grooving, and slot drilling. The machine has a vertical spindle driven by mitre gear ⅝in. pitch, spindle working in parallel bearings of phosphor bronze. The end pressure is taken by an end screw made hollow for lubricating purposes and by loose friction discs with concave faces. The headstock is double geared, carrying a 2½in. belt. The angle slide carries the intermediate slide and the table. The whole of the slides are elevated by a vertical screw, worked by handle shaft and bevel wheels. The table is made to work self-acting with automatic stop action, and is furnished with an instantaneous reversing motion. The self-acting shafts are of steel, and the joints are adjustable to take up wear, the strain being taken by hardened steel conical pins. The whole self-acting arrangement is conveniently open and accessible for inspection and adjustment.

The table has a vertical range of 17in. between table and end of spindle, while the distance from face of machine to centre of vertical spindle is 12in. The longitudinal traverse is 24in., and the transverse traverse 9in.; the table is 20in. long by 10½in. wide. The machine has six changes of speed and five changes of feed. Other particulars, photographs, etc., of these very useful tools may be had from Mr. Taylor at the above address.

Sugar-making Machinery.

XXVII.

FIG. 65 shows the four-roller mill exhibited by Messrs. Mirrlees, Watson and Co., Glasgow, at the late Glasgow Exhibition. Its construction will be readily gathered from the illustration. It consists of two inclined pairs of rolls placed some distance apart, the back pair being set at a lower level than the front, so that the semi-crushed cane from the first set of rolls will readily find its way to the second set, the intervening space between the rolls being covered with a metal plate.

The makers claimed for this mill the following advantages, as compared with the ordinary three-roller mill:—

Firstly: The very heavy stresses tending to separate the rollers, amounting in mills of the sizes in common use to hundreds of tons, are in this mill taken by bolts lying directly in the lines of stress. This allows the framing to be greatly reduced in weight, and confines the risk of breakage to the bolts themselves, which can be made of any required strength, and are comparatively easy to repair or replace. In the three-roller mill it is found necessary to make the cheeks of extraordinary weight and strength to enable them to transmit the diagonal stresses of the rollers to the horizontal and vertical bolts.

Secondly: The trash turner, which is such a fruitful source of trouble and absorbs so much power in the three-roller mill, is entirely dispensed with.

Thirdly: The rollers are connected and driven by gearing wheels of more than twice the diameter of the pinion used with the three-roller mill, which were necessarily of the same diameter as the rollers themselves; and the arrangement of these wheels is such that the opening of the rollers may be adjusted without appreciably altering the depth to which they gear with each other. These large wheels materially assist in reducing the speed of the engine to that required for the mill, bringing the gearing proper within the reach of a single wheel and pinion.

Fourthly: Owing to the considerations stated above, it is expected that the mill will be efficiently driven with much less power than is usually required.

Fifthly: The rollers, gearing wheels, pinions, and covers respectively, are alike and interchangeable.

Sixthly: The mill stands entirely above a level floor, no pits being required for the main bolts, megass elevator, or juice pump. This gives great facilities for cleanliness, there being no place for juice to accumulate and ferment.

The most obvious objection to this type of mill is, that there will always be a tendency for the juice to be reabsorbed by the megass on leaving the last pair of rolls. This difficulty of reabsorption is not absent in the three-roller mill, where, from choking of the trash turner and other causes, the expressed juice often rises over the level of the back roller and escapes with the megass, resulting in considerable loss when it occurs.

With only a pair of rollers nipping the cane, this tendency will be even greater, and it is difficult to avoid the conclusion that this will be the main objection to this mill. Perhaps, if the last pair of rollers were set *higher* than the front pair, and the canes made to travel up to the last pair, this difficulty would most probably be overcome. It would be interesting to know the results of the working of this mill in practice.

Fig. 66 shows an interesting form of mill patented by Messrs. Thomson and Black, of Campos, Brazil, and from which excellent results have been obtained. It is made on licence by more than one maker in this country, and it probably solves the problem of efficient crushing as satisfactorily as it possibly can be. As will be seen, it consists practically of an ordinary three-roller mill, with the addition of two inclined rollers, placed slightly over and in front of the other three rollers, and so arranged that the canes in passing between them are split open, and better prepared to have all the juice expressed out of them, at the same time subjecting them to three distinct pressures. The two front rollers have deep V grooves cut round their circumferences, and are set with the ridges on the one roller opposite the grooves on the other, so that the canes may be completely split in passing between them. The surface of the rollers is sometimes corrugated longitudinally, as well as having deep grooves cut round the circumference, in order to further open up the canes by breaking them into short lengths, as well as splitting them. After leaving the front or splitting rollers the lacerated canes pass immediately between the crushing rollers, where all the really valuable juice is extracted, and the megass, it is stated, leaves the mill so dry that, if the furnaces are suitably arranged, it may be conveyed direct to them as fuel without further drying. These mills, it is stated, have been in use for eight seasons, and with good average canes are said to express from 75 to 80 per cent. of the juice in the canes in a single passage through the rollers. Among the advantages claimed for this mill are its high extraction duty; its adoption does not interfere with existing plant; increased smoothness in working the mill, the canes being drawn in by the splitting rollers without any slipping and in a steady stream; the crushing rollers are regularly and uniformly fed.

TABLE XXIV.—FIVE-ROLLER MILLS.

Engine.		Mill.		Canes Crushed per Hour.
Diam. of Cylinder.	Length of Stroke.	Diam. of Rollers.	Length of Rollers	
in.	in.	in.	in.	tons.
10	20	16	24	2
12	24	18	30	3
14	28	20	36	4
15	30	22	42	5½
16	36	24	48	7
18	42	26	52	9
20	48	28	56	11
24	48	30	60	14
26	48	32	64	18

Unlike the Faure fibre breaker, double crushing with saturation, cane shredder, etc., the canes, after having been lacerated, are only momentarily exposed to the influence of the atmosphere before the juice is entirely expressed by the crushing rollers. The intermediate conductors of the above types are the cause of much extra fermentation, as they became saturated with juice, which soon ferments, and at once affects the juice of the half-crushed canes passing over them, thereby affecting prejudicially the yield of sugar.

Table XXIV. gives a list of sizes of this type of mill, and their engines; also the quantity of canes crushed per hour by each.

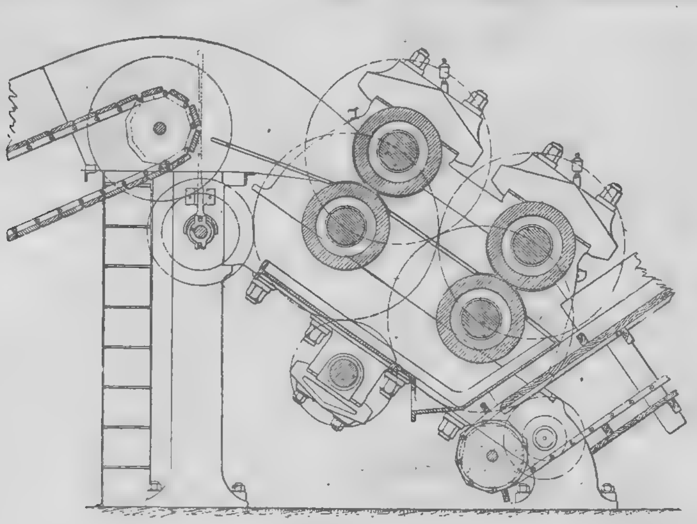


FIG. 65.

SUGAR-MAKING MACHINERY.

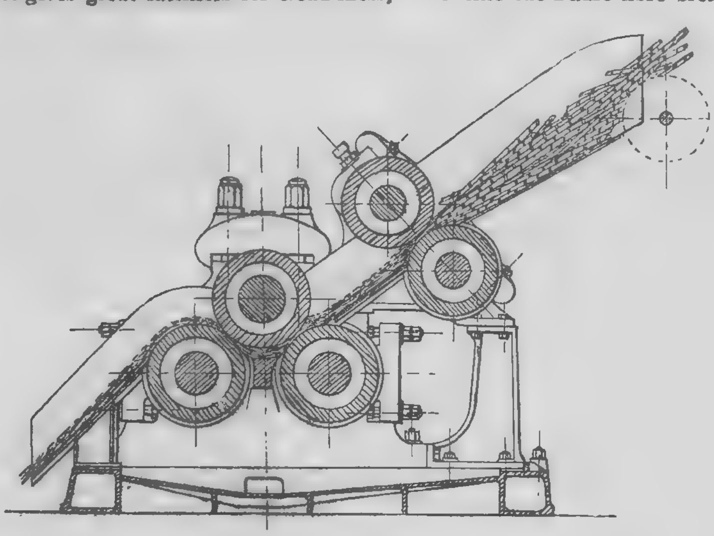
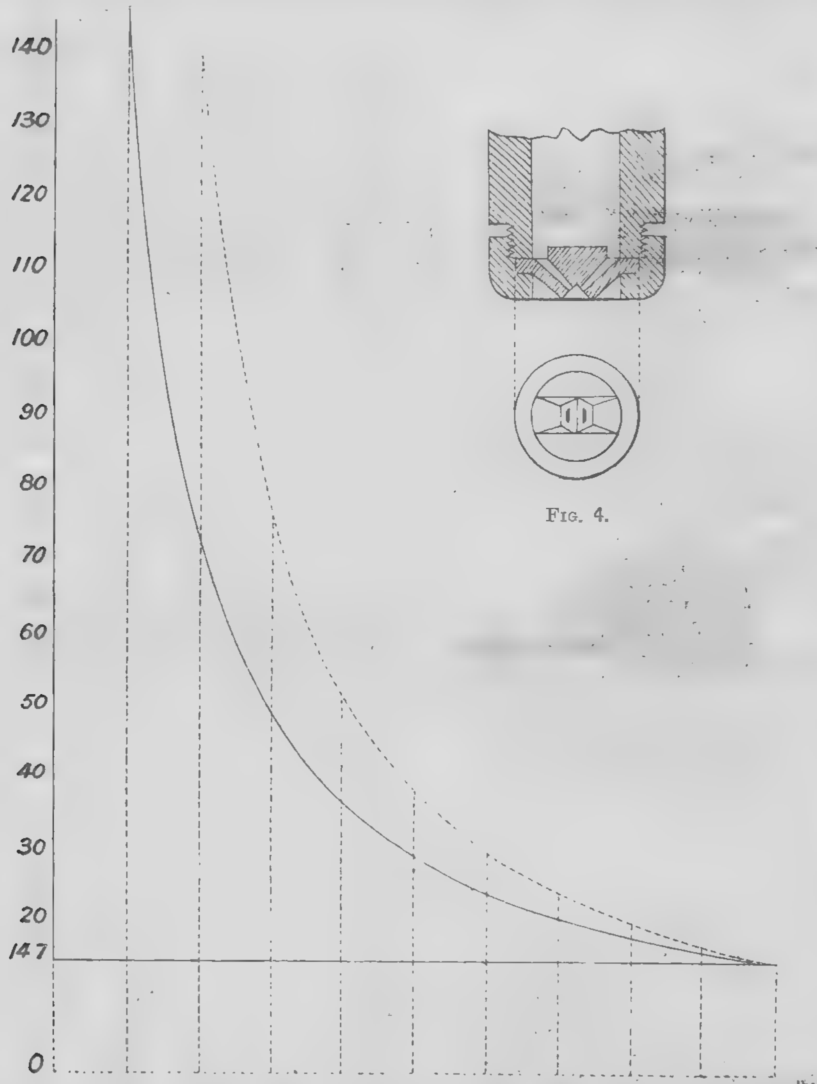


FIG. 66.

The Transmission of Power by Compressed Air.

(*Continued from page 44.*)

HAVING now described the perfect indicator diagram and the very common but very defective one, it will be best to point out the various means that have been adopted to increase the efficiency of compressors and bring them nearer perfection.



P V	= C	147·00	73·5	49·00	36·75	29·4	24·5	21·00	18·40	16·33	14·7	lbs. per sq. in.
P V$^{1·25}$	= C	261·4	109·00	66·20	46·21	34·96	27·84	22·96	19·48	16·77	14·7	„
P V$^{1·28}$	= C	280·50	115·35	68·64	47·49	35·69	28·27	23·20	19·56	16·82	14·7	„
P V$^{1·3}$	= C	293·31	119·12	70·32	48·36	36·19	28·56	23·37	19·64	16·85	14·7	„
P V$^{1·408}$	= C	376·10	141·7	80·10	53·40	39·90	30·17	24·29	20·12	17·06	14·7	„

DIAGRAM SHOWING ADIABATIC AND ISOTHERMAL CURVES WITH TABLE OF ORDINATES FOR INTERMEDIATE CURVES.

FIG. 5.

FIG. 4.

The two defects which were formerly accounted most important were those due to heating and to clearance spaces, and it was thought that they could both be reduced by the introduction of water into the cylinders along with the air during the suction stroke, but it was soon found that water introduced in this way had practically no effect as a cooling agent, though it might have been of some use as a means for reducing clearance spaces. There are, however, so many objections to the use of water in a cylinder, such as difficulties

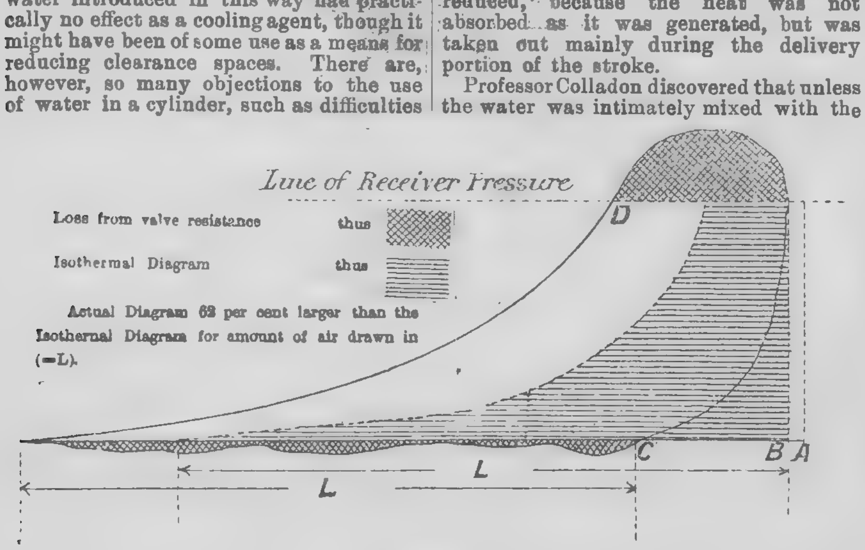
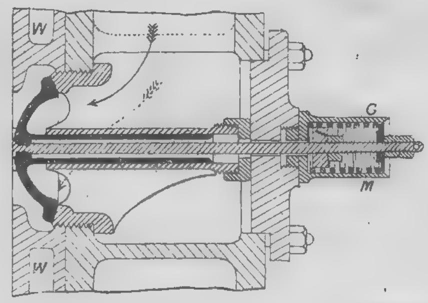


FIG. 6.

of lubrication, of keeping the water free from grit, and of preventing damage from sudden shocks when the piston approaches the end of the stroke, that unless the water can be used more efficiently as a cooling agent its value as a remedy for clearance is not worth considering against the disadvantages attending its use. With water introduced in this way it does not necessarily follow that there is any reduction of the effect of clearance space, because the tendency is to introduce more water than is absolutely required, and it often occurs that the clearance spaces are not only completely filled, but there is so much surplus water introduced that the volume available for drawing in air is no greater than it would have been if the clearance spaces had been allowed full action. The next step was to force the water in by means of a pump during the compression stroke; and while this had the effect of lowering the temperature of delivery, it was found that the work of compression was not materially reduced, because the heat was not absorbed as it was generated, but was taken out mainly during the delivery portion of the stroke.

Professor Colladon discovered that unless the water was intimately mixed with the air in the form of fine spray, it was useless to expect much cooling; so he arranged nozzles like those shown in Fig. 4, in his cylinders, so that water could be pulverised into fine mist and thoroughly mixed with the air during the compression stroke, and by this method a considerable saving can be effected.

The effect of introducing the water during the compression stroke, instead of during the suction stroke, is to completely do away with clearance spaces, without running the risk of overdoing the work by sending in too much water. Compressors of this type—known as the Dubois-François—are very extensively used on the Continent, though the dry compressor seems to suit English ideas better. The presence of water in cylinders is very objectionable when piston rings are used, for the tendency to rust and set the rings fast is very great, and there is a cutting action caused by the water which soon spoils the internal surface of the cylinder. One other point in immediate connection with the wet method of compressing should be mentioned, and that is the fact that air thoroughly saturated with watery vapour takes slightly less power to compress it than dry air alone.



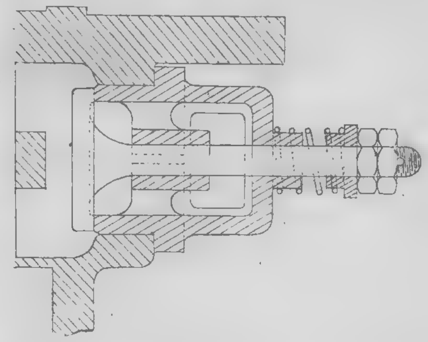
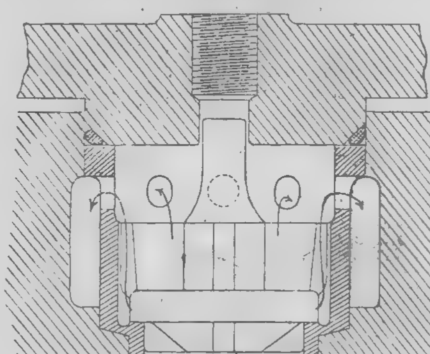


FIG. 7. SUCTION VALVES. FIG. 8.

It is probable that up to this point of development both the wet compressor and the dry compressor were about equal as regards efficiency; for what the wet method gained by more thorough cooling, it probably lost by slower speed and reduced mechanical efficiency, and both of them suffered from the too common defect of too little valve area. On account of the convenience of the position, it seems to be a constant practice to place both the suction and delivery valves in the end covers of the cylinders, the top half usually being appropriated to the suction valves and the bottom half to those for delivery. Now, a very simple calculation will show that if the suction resistance is to be anything less than 1lb. per square inch, the area of opening must be considerably more than can be got, with reasonable lift, in such a space on the cylinder end. In consequence of the restricted area the valves of themselves would take too great lift, and to limit the amount of it so as to prevent the valves from knocking themselves to pieces, heavy springs have been introduced, resulting in great loss of power in valve resistances.



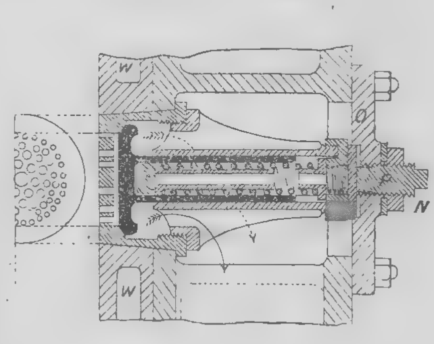


FIG. 9. DELIVERY VALVES. FIG. 10.

It should be borne in mind that 1lb. per square inch due to suction-valve resistance often counts for more waste of power than 4lb. per square inch of delivery valve resistance, because the suction resistance acts throughout the greater part of the stroke, while the delivery resistance is confined to a small amount near the end of it, and 1lb. per square inch on any ordinary-sized piston mount up to a very considerable figure in the course of a day.

But if contracted areas have been the rule with the suction valves, they have been much more so with those for delivery, and it is very remarkable that engines should work at all under such conditions. The cause would be clear if the trouble had sometimes been taken to calculate the velocity of the air during the first part of its exit from a cylinder through these valves. No doubt this has been done at times, but when the result showed that large valves would be necessary, those results have been ignored on account of the great trouble supposed to belong to the use of heavy valves.

There is a still more important defect with heavy valves, and that is during the opening, when the valve tends to go at the velocity of outflowing of the air, often as high as 200ft. per second at the commencement of the delivery stroke, when the piston is going fastest. Springs and buffers of all imaginable kinds are used to prevent the damage caused by the upward blow, but they all have the effect of tending to throttle the passages, and, so far as my experience goes, none of them are perfectly satisfactory. Perhaps the most satisfactory form of buffered automatic-acting valve is that of Messrs. Walker Bros., of Wigan, which is a large valve and closes quietly. Two forms of delivery valves are shown by Figs. 9 and 10, all suffering from the same defects in greater or less degrees, and Figs. 5 and 6 are actual copies of indicator diagrams from Figs. 9 and 10.

Note particularly the great proportional loss of power from insufficient valve area, and the effect of clearance spaces.

(*To be continued.*)

Society of Engineers.

THE first ordinary meeting of the Society of Engineers for the present year was held on Monday evening, the 6th inst., at the Town Hall, Westminster. Mr. J. W. Wilson, jun., the president for 1892, first occupied the chair, and presented the premiums of books awarded for papers read during his year of office—viz., the president's premium to Mr. W. H. Holttum, for his paper on the "Use of Steel Needles in Driving a Tunnel at King's Cross"; the Bessemer premium to Mr. A. G. Drury, for his paper on the "Shortlands and Nunhead Railway"; a society's premium to Mr. B. A. Miller, for his paper on the "Cleansing and Ventilation of Pipe Sewers"; and a society's premium to Mr. S. Sellon, for his paper on "Electrical Traction and its Financial Aspect."

Mr. Wilson introduced the president for the present year (Mr. William Andrew M'Intosh Valon, J.P.) to the meeting, and retired from the chair, receiving a hearty and unanimous vote of thanks for his services during the past year.

The president, having taken the chair, commenced his address by remarking that the rapid development of the principles of engineering science, conducing, as it did, to the health, wealth, and longevity of the human race, could but be gratifying to all, and although the colossal achievements of eminent men for the time astonish the world, the every-day questions of water supply, sanitation, gas supply, the application of electricity, general municipal work, and the education of our young engineers, must hold the field in interest with the general public as with themselves. He then proceeded to enter into the question of the water supply of London, remarking that it was not his intention to decide whether this could be better done by a company or a municipal authority. Until recently no practical result could possibly be the outcome of a discussion on this point. It was only the advent of the County Council that made it possible, and then only by an extension of their present powers. He then went on to say that the

entire Metropolis was at present supplied by companies, one-half the water being taken from the river Thames, the other from the Lea New River, and from underground. From this point he argued that the underground waters in and about the Metropolis were at present a neglected means of providing an efficient supply for the future. Knowledge, he said, had rapidly advanced on this subject during the last 20 or 30 years, due more than anything to the development of railway communication and the construction of the various lines in and around the Metropolis. The supply from the Kent wells was next discussed, and the geological formation of the country south of London described, his remarks being illustrated by diagrams. After thoroughly reviewing the whole question, and judging from experience in the supply of water to sea coast towns from the same source, he came to the conclusion that the chalk was the best, purest, and cheapest source of increase for the future supply of London. At the same time he called attention to the alarming amount of waste of the present supply, not one half the quantity delivered being properly used; and he recommended a plan by which he thought this waste might be checked—viz., by an efficient system of meterage which he described, and proceeded to say it could be used without altering the present mode of charging for water by the rating of property, as this, he thought, would be resisted by Parliament, for the very sufficient reason that it would check its free use by the poor population.

He then passed on to the question of sanitation, glancing at the system employed in London, and said that the present method of disposal was crude and faulty. All must sincerely desire that the time might soon arrive when some practical if not strictly economical system might be devised by which this daily waste could be recovered and returned in an innoxious and useful form, for most surely no such guilty extravagance as is at present practised could be indulged in for any very considerable time without retaliation from natural causes of a kind not at present realisable.

His remarks were further directed to the system of house drain ventilation, which he recommended should be the subject of compulsory legislation, so that the drains conveying the sewage as well as those immediately attached to the house should be properly aerated. His other observations were directed to the municipal work of drainage of coast towns, those of Ramsgate and Margate being specially mentioned, also of other municipal works of interest under construction at Dover and Ramsgate. At the latter town he was constructing a rising road on arches, for which purpose part of the inner basin had been handed over to the local authorities by the Board of Trade, who had just completed under his supervision a new sea wall, which would considerably increase the accommodation of sea-going vessels. The improvement when complete would form a roadway of 2500ft. long, clearing all the buildings away from the Pier Yard, at present hiding the view, and giving an uninterrupted one to the mouth of the harbour and the Downs beyond. He then gave a description of the works now being commenced at Dover, which had been handed to him by the courtesy of the engineers, Messrs. Coode, Son and Matthews.

In concluding his remarks, he referred to the education of young engineers, which he said the Society of Engineers was specially designed to assist. All classes of members of this society had frequent opportunities of visiting works, such as harbours, dockyards, bridges in course of construction, also locomotive and other works, giving the members a most valuable chance of acquiring practical information, and brought his remarks to a final close by saying it was not required that the generation which came to the task to-day should possess larger or better brain power than the past generation; the advantage was in the inheritance of the experience acquired from those who had gone before.

At the close of the address a vote of thanks was heartily accorded to the president.

THE Cleveland ironmasters' returns for January, issued at Middlesbrough on the 3rd inst., show an increase of 41,480 tons, compared with 40,000 increase in December. Stocks have more than doubled in two months. The production of Cleveland iron for January, 122,000 tons, was 6000 tons more than in December. The output of other descriptions, 117,000 tons, was 14,000 tons less than in December. Two more furnaces are on Cleveland iron and four fewer on hematite, etc. One hundred and fifty-six thousand tons of Cleveland iron is in stock, including warrants. The return is deemed unsatisfactory.

The Training of Young Marine Engineers.

A MEETING of the Institute of Marine Engineers was held on January 25, at the premises of the Institute, 58, Romford-road, Stratford, when Mr. S. C. Sage read a paper on "The Training of Young Marine Engineers." Mr. James Adamson (the hon. secretary) presided, and there was a crowded attendance.

Mr. Sage, in the course of his paper, said: Reflecting upon the important positions held by marine engineers, in the industries of our country, it has occurred to me that sufficient consideration is not given to the education of a boy who is intended to be converted into a marine engineer. It is at the age of 12 years, in my opinion, that the education of a boy should be commenced in the direction of the profession he is intended to follow; and in no profession, I am convinced, is such preparatory training more necessary than in that of a marine engineer. By means of the various technical institutes and classes which exist all over the United Kingdom, the ordinary education of a boy can be very readily supplemented, and at the same time the ordinary daily instruction he receives can and should be directed towards the end desired by every means possible. I consider that with a boy of the ordinary amount of intelligence, if it is intended to make a marine engineer of him, his scholastic education should not be prolonged beyond his fifteenth birthday, for, in my opinion, it is better that the drudgery of the first year should be got over before he is much beyond 16 years old. My idea of apprenticeship is, perhaps, somewhat old-fashioned. I believe in the system of indentures; where, for a reasonable premium, the master undertakes to teach the apprentice his trade, and does so, each party carrying out his contract; the master teaching, and the boy submitting to be taught. Although I am of the opinion that a boy who wants to be an engineer, and who has been properly educated, can learn, if properly taught, all the hand-skill there is in engineering proper in three years, I would advocate five years as the duration of the apprenticeship, to allow for all contingencies. Of course, a great deal will depend on circumstances. In my opinion it does not very much matter whether the boy is apprenticed in a locomotive mill or marine engineer's works, as the principle of the steam acting upon the piston is the same in all; the main point being that they be engineers, and teach that trade perfectly. During the serving of his time the apprentice should attend classes of a more advanced nature than he went through at school, but of the same subjects, especially languages, mathematics, and mechanical drawing, and if so inclined, facilities should be given at home in the shape of a small workshop, with a foot-lathe, for him to keep his hand in by making model engines, etc. The boy having now served his time, and arrived nearly at the age of maturity, we will now call him a student of marine engineering, and he should now enter, as an improver, some firm who make and repair marine engines and boilers. He will enter this firm as an engineer, possibly not a marine one; but a year spent with a good firm, and given facilities for observation in all the branches, from the boxing out of the stern frame to the trial trip, will, I have no hesitation in saying, turn him out at the age of 21 years sufficient of a marine engineer to be capable of taking his place at sea as junior engineer, under supervision. Our student being now fairly embarked as an assistant engineer, we may leave him for a time, while he is away on his first voyage, and employ the interval by some consideration of the rules and regulations of the Board of Trade, through whose hands he must pass before he can be dubbed correctly an engineer of the mercantile marine of Great Britain. These regulations, of course, are very well known to most of those present this evening; and before I make any remarks upon them I will just give a few particulars of the rules under which the engineers of some foreign and friendly nations, especially the Dutch and German, are granted certificates; and I think, when you have heard them read, you will agree with me that we might, with advantage to our profession, adopt a few of their regulations. I refer particularly to the point that they have certificates for third engineers; and I think the time has now come—considering the pitch to which the machinery of even an ordinary tramp steamer has arrived—when, as is too often the case, ships with feed heaters, evaporators, grease extractors, hygrometers, refrigerators, electric-light installations, etc., should not be sent to sea with only three engineers, one of whom is probably upon his first voyage and comparatively ignorant of what duties are expected of him. All ships above a certain tonnage should, in my opinion, have three engineers, all certificated, and as many juniors or assistants as the circumstances of the voyage and vessel demand, and no engineer should be allowed the charge of a watch in them at sea who was not certificated. All ships making voyages of longer than four days' average duration should have no less than three engineers, and the third engineer, if not certificated, should not be allowed to take charge of the watch alone on his first voyage at sea.

(*To be continued.*)

The Birmingham Association of Mechanical Engineers.

THE ordinary monthly meeting of the above association was held on Saturday, the 4th inst., at the Grand Hotel, Birmingham. The chair was taken by the president, Mr. A. Driver, and about 65 members were present. After the ordinary business had been transacted, it was unanimously resolved, upon the motion of Mr. J. Neville, seconded by Mr. J. Mills, and supported by Messrs. H. Winwood, J. Floyo, and G. Birkbeck, that the sum of £5 5s. be presented annually to the Birmingham Municipal Technical School for the purpose of establishing a scholarship or exhibition in connection with the practical engineering classes. A paper was then read on "Körting's Condenser," by Mr. E. Flint, C.E., at the conclusion of which an animated discussion ensued, which was taken part in by Messrs. T. Meacock, H. Winwood, J. Smith, and E. Hazel. The questions asked were satisfactorily answered by Mr. Flint, after which a cordial vote of thanks was passed to the lecturer, which having been suitably acknowledged the proceedings closed.

Metal Trade Memoranda.

The export of gold from Cape Colony during the month of January amounted in value to £404,000, as compared with £330,000 in the corresponding month of last year.

A tinplate plant will soon be put in operation in Baltimore. It is owned by the Baltimore Iron, Steel and Tinplate Company, and is really a branch of the Cwmpelin Tinplate Company of Swansea, one of the largest tin manufacturers of Wales. It is not intended at present to roll tinplate at the Baltimore Works, but to put the coating of tin on the black or steel plate.

According to the ascertainments of the Society of German Iron and Steel Producers, the production of crude iron in the German Empire (including Luxemburg) during the year 1892 reached a total of 4,793,003 tons, as compared with 4,452,019 tons in 1891. Thus, instead of there being a diminution, as had been expected in some quarters, there was an increase to the extent of 340,984 tons.

According to the copper statistics furnished by Messrs. Henry B. Merton and Co., the total stocks on January 31 were 54,757 tons, as compared with 55,062 tons on the same date last year, and 50,745 tons on December 31 last. There were advised by mail and cable 8750 tons, against 2400 tons at the corresponding date, and 5000 tons on December 31 last. The grand total was therefore 58,507 tons, against 57,462 tons a year ago, and 55,745 tons at the end of December.

The Arizona Copper Company Limited have recently made experiments near New York, on a quantity of the tailings from the Company's Concentration Mill, for the extraction by means of a sulphuric-acid leaching process of the copper contained therein. The results have been deemed so satisfactory by the experts, that the directors have felt warranted in giving instructions for the immediate erection at Clifton of a plant for the manufacture of sulphuric acid, and of leaching works for treating the tailings.

Official Gazette.

Partnerships Dissolved.

J. J. EVANS and W. H. MAY, under the style of W. Evans and Sons, Newport, Monmouthshire, smiths and boiler makers, iron and brassfounders, coppersmiths, engineers, and ship repairers.

W. H. KITTO, F. DUFF, and H. B. DREW, under the style of W. H Kitto and Co., Plymouth, general engineers and cycle manufacturers.

N. SMITH, G. SMITH, and E. SMITH, under the style of Smith and Grace, Thrapston, engineers, iron and brassfounders, and agricultural implement makers; as far as regards N. Smith.

J. ASHFORD, the younger, and J. F. CARR, under the style of Carr and Ashford, Birmingham, engineers, ironfounders, and safe manufacturers.

R. WELFORD and W. WELFORD, under the style of Welford Brothers, Sunderland, engineers and boiler manufacturers.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Receiving Orders.

H. MCGOWAN, Liverpool; and H. A. HADWEN, Fairfield, near Ashton-under-Lyne, formerly trading as McGowan and Hadwen, Manchester, late ironfounders.

T. W. SIDDAWAY, Southport, late West Bromwich, out of business, late ironfounder.

Adjudication.

H. MCGOWAN, Liverpool, and H. A. HADWEN, Ashton-under-Lyne (formerly trading as McGowan and Hadwen), Manchester, late ironfounders.

New Companies.

DYNEVOR SPELTER COMPANY LIMITED.—This company was registered on the 30th ult., with a capital of £20,000, in £50 shares, to manufacture and sell spelter, lead, chloride of zinc, zinc oxide, paint, galvanising, copper, yellow metal; to purchase, acquire, lease, and occupy, or hire lands, buildings, etc., and to extract from the ores, reduce, smelt, and manufacture spelter, etc. The number of directors is not to be less than 3, nor more than 7; qualification, 2 shares; remuneration not stated. Registered office, Dynevor, near Neath.

GENERAL METALLURGICAL COMPANY LIMITED.—This company was registered on the 30th ult., with a capital of £5000, in £1 shares, to acquire the secret process of manipulating or blending metals and mineral ores for the production of metallic gold and other metals, the invention of Mr. J. M. Stuart, and to spend money on improving other certain patents of a similar character. The number of directors is not to be less than 3, nor more than 9; remuneration to be fixed in general meeting. Registered by Jordan and Sons, 120, Chancery-lane, W.C. Registered office, 4, Abchurch-yard, Cannon-street, E.C.

The Metal Market.

PRICES CURRENT.

LONDON, Feb. 6.

COPPER opened steadily, with business in three months at £46 10s.; but, owing to the poor demand, values afterwards drooped, and four and six days prompt passed at £46. Later on cash, influenced by a disposition to realise, went at £45 17s. 6d., and prices then became irregular, middle March making £46 3s. 9d., and the end of February £46 1s. 3d. A decline followed to £45 18s. 9d. middle February, and £46 7s. 6d. three months; but a slight rally took place later, offerings being lighter, and £45 18s. 9d. was paid for cash and early delivery. The market, however, lacked strength, and after the official close £46 7s. 6d. was taken for three months, the close being quiet at 2s. 6d. decline. Sales, 600 tons. Settlement price, £45 17s. 6d.; English tough, £48 10s. to £49; best selected, £50 to £50 10s.; strong sheets, £58.

TIN gained 2s. 6d. on prominent cash buying at the opening, and with a good speculative demand three months sharply rose to £92 10s., and later to £92 15s., the market showing some excitement, and cash realised £92. Later on, however, three months was sold at £92 12s. 6d., and, with the cessation of active buying, the tone ruled quiet, £91 17s. 6d. being accepted for cash towards the close. It is understood that orders are being steadily executed on American account. The close is steady at 2s. 6d. to 7s. 6d. advance. Sales, 170 tons. Settlement price, £92. English ingots, £95 to £95 10s.

PIG IRON opened firm, and afterwards showed strength, though the demand was only limited for cash, for which 46s. was eventually paid, and early trading left off with buyers at 45s. 8d. Towards the close 41s. 9d. was bid for three months, but there were no offerings under 42s., and the close is firm at the highest point, or 9d. better on the day. Sales, 500 tons. Settlement prices:—Scotch, 46s.; Middlesbrough, 35s. 1d.; hematite, 45s 9d.

TINPLATES remain dull, and prices are unchanged.

LEAD has a quiet market at £9 12s. 6d. to £9 15s. for Spanish. English, £9 17s. 6d.

SPELTER is 2s. 6d. better on lighter offerings February shipment, £17 7s. 6d. buyers, £17 10s. sellers. Silesian specials, £17 12s. 6d.

ZINC SHEETS.—Silesian are 5s. down at £20 7s. 6d. ex ship., the demand being slow. Belgian are quiet and unchanged: V.M. brand, £20 17s. 6d. ex ship, £20 15s. f.o.b. Antwerp.

ANTIMONY is quoted £41, but the market is inactive.

QUICKSILVER has ruled firm from second hands at £6 1s. 9d. to £6 5s.; first hands, £6 5s.

OFFICIAL CLOSING QUOTATIONS.

	To-day. £ s. d.	£ s. d.
COPPER—		
G. M. B.—Cash	45 18 9	—46 6 3
" Three months	46 8 9	—46 16 3
English tough	—	— —
Best selected	—	— —
Strong sheets	—	— —
TIN—		
Fine foreign—Cash	92 0 0	—92 10 0
" " Three months	92 12 6	—93 2 6
Australian—Cash	92 10 0	—93 0 0
PIG IRON—	s. d.	
Scotch warrants—Cash	46 0	
" One month	—	
Middlesbrough—Cash	35 1½	
" One month	—	
Hematite—Cash	45 9	
" One month	—	

GLASGOW, Feb. 6.—The business on the pig iron market was confined to the sale of 500 tons Scotch at 45s. 9d. cash. Dealing is now entirely directed to squaring oversold accounts. It is said that the London syndicate have sold several thousand tons privately at over 46s., but there is still a heavy balance to settle, and as only small lots can be had in the market, it is impossible to say where prices may go if holders are disposed to press. The shipments of Scotch last week were 4816 tons, an increase of 239 tons on the corresponding week of last year.

QUOTATIONS.

	Highest. s. d.	Lowest. s. d.
Scotch warrants—Cash	45 9	45 9
" One month	45 6	45 6
Middlesbrough—Cash	35 1½	35 1½
" One month	—	—
Hematite—Cash	45 9	45 9
" One month	—	—

Letters to the Editor.

⁂ We do not hold ourselves responsible for opinions expressed by correspondents.

⁂ The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.

⁂ Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

MECHANICAL AND ENGINEERING DRAWING.

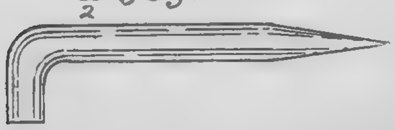
To the Editor of THE MECHANICAL WORLD.

SIR,—Although it is over 30 years since I first handled a tee and set square, I have read the articles on this subject with considerable interest. I take it that the writer's object is to write the subject up to date. I am therefore rather disappointed with the last contribution, and what your author says upon the subject of drawing pins and Indian ink, as on these points he is at least a dozen years behind.

I enclose you a sample of drawing pins by which you will see that they completely avoid all the disadvantages of projecting heads, and any number of them can be put in at the top, bottom, and sides of the paper without interfering with either tee or set squares. These drawing pins, you will see, consist of small copper tacks about $\frac{3}{16}$in. long, and the heads are little thicker than a sheet of good writing paper.

No particular tool is necessary in the use of these tacks, but a very handy tool can be made out of a piece of $\frac{3}{8}$in. round iron, as per sketch enclosed. One end acts as a hammer, and the other end is made like a screw-driver point to extract the tacks. By using this tool these tacks can be made to do duty over and over again.

½ size



The above may be a small matter, but it puzzles me how the writer could, whilst on the subject of Indian ink, have overlooked the merits of liquid ink and recommended the old-fashioned solid stick, which is such an utter abomination to anyone who has once used the liquid ink. In THE MECHANICAL WORLD, vol. xi., page 211, you illustrated the handiest form in which fluid ink may be obtained. If your readers will take the trouble to refer back to your illustration they will see that the liquid ink is contained in a squat bottle not easily overturned, and the cork contains a quill already inserted. The ink is jet black, is always ready, and the quill is handy for filling the pen. Some ten years ago the bottles were of the same shape as now, but in those days one had to bore the cork and fit in a quill. The ink above referred to is of American manufacture; and the cork with quill is patented in this country, and I have no difficulty in obtaining it in London at 1s. a bottle. I do not know that the American-made ink is any better than that made in England, but the English bottles are of an unhandy shape, very easily upset, and unless one fits the cork with a quill a writing pen must be used to charge the drawing pen. Both of these inks can be obtained from any respectable mathematical-instrument maker, and the English ink is rather cheaper, and can be had at from 9d. to 10d. a bottle. The time saved in the use of liquid ink will far exceed any extra cost of the article, besides the extra finish that can be put upon a drawing when it is employed.

I trust your author will duly enlighten the rising generation of draughtsmen upon the modern practice of tracing off a pencil drawing, and the best mode of preparing a tracing for blue printing. J. D.

Brentford, Jan. 31.

TRANSVERSE STRESS.

To the Editor of THE MECHANICAL WORLD.

SIR,—If "Mechanical Draughtsman" carefully compares the two formulæ in which the constants occur he will find that they practically agree. In fact the constants seem to be derived from Barlow's experiments. Take, for example, a solid cast-iron beam 1in. square, supported at each end; distance between supports, 12in.

The modulus of rupture, according to Rankine, for a solid cast-iron rectangular beam, is from 33,000 to 43,500, not 17,000 as given by your correspondent. Then $\frac{1}{6}bd^2\ 33{,}000 = \frac{L}{4}w$. L = length in inches, w = breaking weight in lb., and $\frac{4}{12}\ \frac{bd^2}{6}$ $33{,}000 = w$, $bd^2\ \frac{33{,}000}{18} = bd^2\ 1800$ nearly $= w$. It will be seen that the modulus of rupture is 18 times the breaking load of a beam 1in. square, supported at each end, distance between supports = 12in. Now, reducing the formula $\frac{1}{6}bd^2\ 33{,}000 = \frac{L}{4}w$ to that given by Molesworth, thus, by transposition:—$\frac{4}{12}\ \frac{bd^2}{6}\ 33{,}000 = \frac{4}{12}bd^2$ $5500 = bd^2\ 1800$ nearly $= w$. The constant 5500 = 2·4 tons, practically the same as given by Molesworth. The modulus of rupture is not the stress per square inch of solid beams, although it may represent the stress in the skin or the extreme fibres.

The mean stress per square inch may be arrived at by equating the bending moment to the moment of resistance $\frac{L}{4}\ w = \frac{2}{3}\ dfa$ where d = depth of beam, a = sectional area of that portion of beam above or below the neutral axis, $f = \frac{L}{4}\ w\ \frac{3}{2}\ \frac{d}{a}$, which becomes for the beam under consideration, $f = \frac{3}{8}\ \frac{Lw}{a} = \frac{3 \times 12 \times 1800}{8 \times 0{\cdot}5} = 16{,}200$lb. = 7·2 tons per square inch.

I think, sir, your correspondent's letter shows clearly the danger in applying formulæ when not thoroughly understood.

Leeds, Jan. 30. W. CAMERON.

THE MANUFACTURE OF COAL GAS.

To the Editor of THE MECHANICAL WORLD.

SIR,—Believing that the extended use of gas for heating purposes is the most feasible way of preventing the smoke nuisance in our large towns and cities, in so far, at least, as that is caused by domestic fires, I was much interested in the letter of T. Nicholson, on the manufacture of gas, that appeared in your issue of the 27th ult. The writer seems to advocate the use of gas only; but supposing all the coal that is at present used in domestic fires was turned into gas, what would be done with the resulting coke or cinder? Would there be sufficient demand for it otherwise, and, if not, would it not do to burn it in open grates along with gas?

Perhaps your correspondent may be able to give information on these points, which I am sure would be of interest to other readers as well as to W.

Glasgow, Feb. 4.

LOCOMOTIVES IN AUSTRALIA.

To the Editor of THE MECHANICAL WORLD.

SIR,—Under the heading of "Miscellaneous Items," a paragraph appears in last week's issue to the effect that "the *first* locomotive built in Australia has just been completed at the works of David Munro and Co., Melbourne, for the Victorian Railway Department." As a native of Victoria, and in justice to my native land, I wish to inform you that as far back as 1880 six locomotives were built by Messrs. Robison Bros., of Melbourne, for the Victoria railways, and since then the Phœnix Foundry Company, of Ballarat, Victoria, have completed several contracts for locomotives for the Victoria railways. I should say there were considerably over 100 engines built by them now running on our lines; in fact, for several years all locomotives required by the Victoria Railway Department have been built in that colony. Trusting you will find space for this correction. W. M. S.

Leeds, Feb. 5.

Miscellaneous Items.

Good progress is being made with the construction of the electric tramway, on the overhead system, between Singapore and Johore.

The cable which is being laid down between Marseilles and Tunis is the second which has been made in France. It was commenced at St. Tropez, a small town near Toulon, on October 15 last, and was completed on the 3rd ult., having given occupation to 250 workmen, and being 725 miles in length.

The celebrated Graigola seam of coal was struck on the 28th ult., at one of the new pits being sunk by the Main Colliery Company Limited, at Brynocoh, near Neath. It was found at a depth of 430yds., and proves to be 6ft. thick. 3000 acres of mineral property, and the new pits will develop a large area. These pits were commenced in September, 1891.

The death is announced at Antwerp of M. Van Rysselbergh, the celebrated electrician, who was best known by his invention of the meteorgraph. A few years ago he attracted great attention in technical circles by his discovery of the system of employing telegraph lines for telephone communication, as well as for the transmission of telegraphic despatches.

The old wooden line-of-battle-ship "Royal Adelaide," almost the last of the old three-deckers in existence, has been internally almost reconstructed in Chatham Dockyard, where she has been converted into a receiving ship for the petty officers and sailors at the port. The "Forte," an old wooden two-decker, is being fitted up in a similar manner to the "Royal Adelaide," to be stationed at Chatham as a second receiving ship, the intention of selling the "Forte" out of the service having been abandoned.

Lord Salisbury formally opened the Liverpool Electrical Overhead Railway on the 4th inst. Accompanied by the Earl of Lathom, Sir William Forwood, and Mr. A. B. Forwood, M.P., he arrived at the station at Bramley Moor Dock, where the electricity is generated, and set in motion one of the four engines which have been made for the purpose. He next pressed a button which set in motion the electric current and charged the motors attached to the trains on the railway. His lordship was then taken along the whole length of the line.

The death occurred on the 3rd inst. of Mr. J. E. H. Gordon, of Queen's-gate-gardens, London, who was killed by a fall from his horse. Throughout his life electricity, both in its scientific and practical developments, was to him an absorbing passion. In his early days he contributed papers on electrical subjects to the Philosophical Transactions, and was engaged in connection with the University extension scheme in lecturing on electricity and other branches of physical science. In 1878, the year of Mr. Spottiswoode's presidency, he became assistant secretary of the British Association. In 1880 he brought out "A Physical Treatise on Electricity and Magnetism," an important work, now in its third edition, which has commanded considerable attention in this country, and also in France and America. Later on he engaged in the more active work of an electrical engineer, and designed and carried out many important electric-lighting stations.

We get most light from gas by diminishing as much as possible the blue part of the flame, and heating its blackish carbon particles to luminous incandescence. Sir James Douglas did this rather cleverly by having a lot of flames one burning inside the other. A current of air hit the outer flames at the base, and though they did not give much light the inner ones were so intensely heated that they glowed with double power. Another plan is to make the flames from two burners impinge on one another. Of course part of the heat radiated from one flame heats the other, and the updraught at the base produces an intense glow on the blue part of the gas-flame. Cluster burners used in street lamps illustrate the working of this plan. But the latest experiments of Professor Lewes seem to show that if we want to make a flat flame burn more brightly we must make it thicker and then by some dodge get a strong draught of air to play on the flat part of the bottom of the flame.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

POOLE'S GRINDING MACHINE FOR LATHES.—Required, the address of makers of this machine,

DISINFECTANT.—Will any reader kindly tell me how to make a cheap and effective disinfectant powder?—BOILERS.

FILTRATION.—Will any reader state the best method of filtering 150 gallons of canal water per day for steam-boiler purposes?—T. H. MITCHELL.

TWIST DRILL CUTTERS.—Can any reader give me a method of getting the correct thickness and shape of cutter for any diameter of twist drill, straight lip? A drawing will greatly oblige.—J. M. F.

"GRASS" PACKING.—Can any reader supply me with the address of manufacturers of this packing? I have seen it used for the piston and valve rods of L. and N.-W. Railway engines.—LOCO.

ENGINEERS' WAGES.—Would any reader kindly give me some information as to the wages at Cape Colony and Mexico for mechanical engineers?—REGULAR READER OF "THE MECHANICAL WORLD."

HEATING FURNACE.—Will any reader kindly give particulars, with rough sketch, of furnace suitable for heating and fagotting iron up to 3in. diameter and about 2ft. long for 2cwt. steam hammer?—HAMMER.

MAKERS OF BUILDERS' IRONWORK.—Can any reader furnish me with addresses of firms who are makers of machinery for making builders' ironwork, such as bands and hooks, cavity irons, etc?—SMITH.

TRACTION ENGINE.—Would any maker or user of modern traction engines kindly give the weight of traction engine capable of drawing 20 tons net weight; also average consumption of coal and speed in miles per hour with and without load, and at what degree of ascent and descent is it capable of taking the load with safety, taking in all cases the average road?—J. W.

LOCOMOTIVE.—Will any reader of THE MECHANICAL WORLD kindly give me the best way to trammel a locomotive which has too much play in the axle boxes and more on one side than the other? There are no centre marks on the crankpins.—DUBBS.

ELECTRICAL RESISTANCE.—Can any reader give me any information relative to the resistance offered to the passage of electricity by carbon rods and platinium wire? Is there a small work published on the subject? If I had formula, I could work out myself.—CARBON.

LOSSES IN STEEL FURNACES.—Could any reader kindly inform me the average per cent. of actual loss, and the average per cent. of skull, in the charge of a Siemens open-hearth steel furnace working charges of from 30 to 40 tons? And also the percentage of loss in heating slabs and ingots in the Siemens regenerative gas furnace?—J. R. R.

COAL MINING.—Will some reader of THE MECHANICAL WORLD kindly say how many tubs should be run each journey to work an incline of 1 in 14 and 1100ft. long, so arranged that the full tubs going down will bring up the empty ones? Weight of tubs, full, 15cwt.; empty, 5cwt. each; would two tubs each journey be sufficient? Which would be the best to lower the tubs with—a brake drum or a horizontal brake pulley? Please say how to calculate the weights for working inclines of various gradients when arranged as the above.—AUTOMATIC.

WINDING ENGINE.—What weight would a pair of 36in. cylinder engines by 4½ft. stroke raise from a pit with a spiral drum, commencing at 14ft. and finishing at 18ft. diameter, one side to wind from a depth of 350yds. and the other side from 400yds.; ropes to be 1½in. diameter, boiler pressure 80lb. per square inch, cut-off at ¾ stroke? What weight would the above engines raise from a depth of 280yds., with a flat rope drum, commencing at 12ft. diameter; sizes of ropes 5½in. by ⅝in. (steel)? What would be the rise in inches per yard of a slant whose angle is 26 degrees?—MINER.

BRAKE-WHEELS, WINCHES, ETC.—(1.) Are there any reliable rules for the design and construction of brake wheels and straps; also, what is the method of calculating the strains on the above as applied to cranes, crabs, and winches? (2.) Is there any formula for finding the diameter and width necessary for a roller on jib bottom to travel on roller path? (3.) What is the method by which the strains on the sides of crabs, winches (C. I. and W. I.), A, circular and other designs of frames, are worked out? Any information on the above would greatly aid.—F. W.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

DAKIF.—(1.) Yes. (2.) Yes. (3.) See article in our next issue.

T. L.—We hope to insert an article in our next which will fully answer your query.

H. C. G.—(1.) You cannot do what you propose with any degree of satisfaction. (2.) You can obtain the lamp from the Lithanode and General Electric Company, 64, Millbank-street, Westminster, London, S.W.

H. A. S.—If we understand you rightly, the Tabor moulding machine will best meet your requirements. Particulars may be had from the Globe Engineering Company, 38, Victoria-buildings, Manchester.

MON.—A knowledge of elementary mathematics is not absolutely essential, but you will find that you will not be able to proceed very far without requiring such knowledge, and we should certainly advise you to take up the subject.

R. LACEY.—You could, of course, speed up your dynamo by substituting a larger driving pulley for that now on the engine, or by placing a similar one on the dynamo. We should think, however, that the regulator must be out of order.

NEMO.—The examinations for marine engineers have no connection with those of the Science and Art Department. We should advise you to attend classes on steam, applied mechanics, machine construction and drawing, and elementary mathematics.

BOILERMAKER.—Procure copies of "Regulations and Suggestions as to the Survey of Steamships," to be obtained of John Menzies, 21, Drury street, Glasgow, price 6d.; also of Lloyd's "Rules and Regulations for the Construction and Classification of Vessels," 6s., to be had from Lloyd's Register, 2, White Lion-court, Cornhill London.

SPECIFICATION.—(1.) The application for patent you refer to is only under provisional protection, and may never be published at all. If the inventor completes the application the specification may be published any time within the next nine months. It is almost certain to be granted (2.) This is partly answered in 1. No provisional specifications are ever published; only when the complete specification has been filed. (3.) Yes. The manager of our Patents Department will always be pleased to help you. We are sending you a small pamphlet which will help you to understand what is referred to above.

W. G. BROWN.—Try the following:—First coat the files with a paste prepared by boiling glue and salt in yeast and thickened by an addition of wood charcoal and graphite. Upon this coat is scattered a coarse powder consisting of a mixture of horn, wood charcoal, and common salt. A solid crust is formed upon the files, which protects them from a displacement of the cuts by the metal and conveys to them oxygen while being heated. For tempering, the files are plunged into a lead bath. To prevent the oxidisation of the lead on the surface a mixture of potash, soda, and tartar is scattered upon it. The files remain in the bath five to eight minutes, according to their thickness, and are then immersed in water.

PURE COPPER CASTINGS.—Will any reader kindly tell me the way I can cast pure copper castings free from tiny holes, which often show themselves when machined. They are generally found with a whitish metal with it.

What firm could supply such castings free from the above defects, and at the same time pure?—PURE COPPER.——*A.*—The usual way is to pole the copper before casting. The process is as follows:—The molten metal is covered with wood, charcoal, or anthracite to protect from oxidisation; then the metal is stirred with a pole of young birch or fir. When sufficiently poled, a sample is taken and nicked with a chisel and then broken exhibits a fine close grain, and is of a light red colour. The copper in this state is said to be a tough pitch. The poling removes the oxygen, as the combustible gases generated in the wood by the heat gradually remove the oxygen from the metal.—B. S.——*A.*—If you will communicate with W. D. Barker, brass-founder, Railway-street, York, he will supply you.

STRESSES IN BEAMS.—(1.) What is the shearing force and bending moment at the fixed end of a bracket whose length is 14ft., and which carries one ton at the free end and two tons at 4ft. from that end? (2.) A beam of 20ft. span, supported at both ends, carries a weight of 6 tons at 5ft. from one support, and another of 7 tons at 8ft. from the same support. Calculate the reactions at each support, and the bending moments at each load.—R. B.——*A.*—(1.) The bracket in question may be considered as a cantilever. $BM = Wl + W^1 l^1 = 1 \times 14 + 2 \times 10 = 34$ft.-tons. The leverage ($l$ and l^1) is always the distance from the

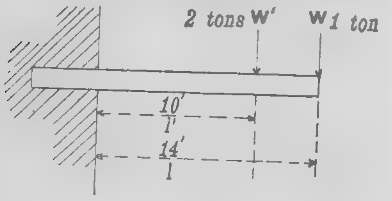


FIG. 1.

weight to the section under consideration. (2.) The reaction (R) at one end must first be ascertained; and this is $R\,l = W\,l^1 + W^1 l^2 = \frac{7 \times 8 + 6 \times 5}{20} = 4{\cdot}3$ tons reaction at B. Reaction at $A = W + W^1 -$ reaction $B = 8{\cdot}7$ tons. Bending moment at 6-ton load $= R$ at $A \times l^2 = 8{\cdot}7 \times 5 = 43{\cdot}5$ tons. Bending moment

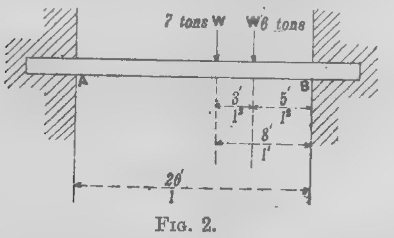


FIG. 2.

at 7-ton load $= R$ at $A \times l^2 - W^1 \times l = 8{\cdot}7 \times 8 - 6 \times 3 = 51{\cdot}6$ tons. The reactions at A and B may be found graphically by the application of Prof. Cullmann's diagram. Fig. 3 represents the beam with its loads. Draw A, B, C

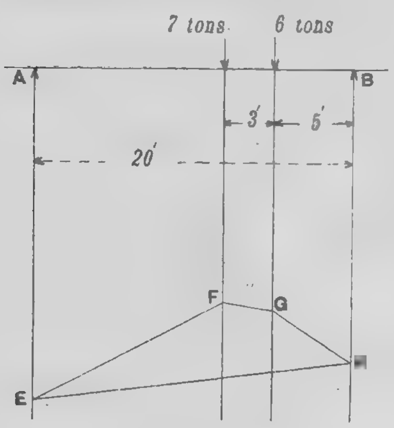


FIG. 3.

(Fig. 4), making A B = 7 tons, and B C = 6 tons. From point O draw O A, etc. Take any point E (Fig. 3) in the line A, and draw E F parallel to O A, and F G parallel to O B, etc. Draw O I (Fig. 4) parallel to E H (Fig. 3)

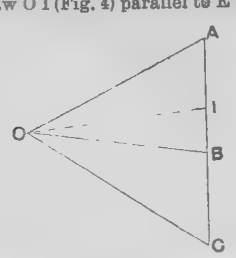


FIG. 4.

Then A I scales 4·3 tons, the reaction at B, and I C 8·7 tons, the reaction at A.—A. J. C. ——*A.*—(1.) The shearing force at the fixed end of any cantilever is simply the whole weight on all and any part of the cantilever. Here, therefore, it is 3 tons. The bending moment is the sum of the products of each weight into its distance from its point of support. Thus:—

$$14 \times 1 = 14 \text{ tons} + 10 \times 2 = 20 \text{ tons} = 34\text{ft.-tons.}$$

(2.) The reactions are as follow:—Let A be the left-hand support, and B the right-hand one, and let the distances be measured from A. Then reaction at A =

$$\left(\frac{15}{20} \times 6\right) + \left(\frac{12}{20} \times 7\right) = \frac{87}{10} \text{ tons.}$$

Reaction at B =

$$\left(\frac{5}{20} \times 6\right) + \left(\frac{8}{27} \times 7\right) = \frac{43}{10} \text{ tons.}$$

The bending moments at each load are simply the reactions at either support multiplied by the distances of the loads from such supports, thus:—Bending moment at 5ft. from $A = \frac{87}{10} \times 5 = 43{\cdot}5$ft.-tons. Bending moment at 8ft. from $A = \frac{87}{10} \times 8 = 69{\cdot}6$ft. tons.—T. J. B.

BLOWERS *v.* FANS.—Will any reader supply me with some reliable data for calculating the power required to drive blowers and fans? I would also be glad of an opinion with regard to their comparative merits in blowing blacksmiths' fires.—POWER.——*A.*—The essential difference between a blower and a fan is that the former has a positive action, forcing the air through the pipes, as a pump forces water, while the latter's action depends on impact of the vanes against particles of air. It would be possible for a blower when all the exit for the air was cut off to accumulate pressure in the pipes, and in time stop itself working, like a Worthington pump when the water pressure exceeds the steam pressure. A fan, on the other hand, would not be so stopped, as it would continue revolving in a slightly compressed atmosphere, the air sliding obliquely from the vanes. As a fan must be driven at from 1500 to 3000 revolutions per minute, countershafts, belting, etc., must be used to an extent involving a great loss of power by friction. A blower requires from 300 to 400 revolutions per minute only, and requires less power to do the same amount of work. A blower is generally considered preferable to a fan for blacksmiths' fires, though costing from two to three times as much for the machine itself, exclusive of shafting and belts, etc. The following are some particulars of blowers and the power required to drive them. It is scarcely practicable to calculate the power required to drive machines with any certainty:—

No. of Smiths' Fires.	Revolutions per Minute.	Approximate N.H.P.
6	350	1
10	400	2
18	400	4
30	380	6
70	320	10

From these particulars for blowers may be estimated roughly the power required for fans.—T. J. B.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

23rd January, 1893.

1394 WATER TUBE BOILERS.* W P Thompson. (*L B Battin*, United States.)
1400 APPARATUS for REGULATING the PROPELLER SHAFTS of MARINE ENGINES. A C Haley.
1407 PRODUCTION of ALUMINIUM. C Allan and others.
1411 AUTOMATICALLY VARYING the PRESSURE of GAS in MAINS or PIPES. J T Sheard.
1416 ELECTRIC ALARUM for USE in HOTELS, ETC. L G Weygang.
1417 APPARATUS USED in the MANUFACTURE of GAS RETORTS. H Coulthurst and others.
1420 STEAM SIGNALLING APPARATUS. J Washington.
1422 MITRE CRAMP.* T Avill and others.
1426 SPEED REGULATORS for STEAM ENGINES. E Rayner and G F Alder.
1432 APPARATUS for ASPIRATING and PROPELLING, HUMIDIFYING or MIXING AIR or OTHER GASES. A R Sennett.
1433 COMBUSTION of FUEL and PREVENTION of SMOKE. A R Sennett.
1434 GRATE BARS. Z W Baugh.
1435 SUPPORTER for the RECEIVERS of TELEPHONES. A Connell.
1437 ELIMINATION of SULPHUR from MOLTEN IRON or STEEL. H J Phillips.
1440 OILCANS. D McCarthy.
1441 ELECTRIC STORAGE BATTERY PLATES. E Bailey and J D Massey.
1445 TUNNEL BORING or EXCAVATING APPARATUS. J J Robins.
1449 ELECTRICAL HOSE SIGNALLING APPARATUS.* W Fowler.
1455 CONTROLLING and STEERING BALLOONS. H S Playfair.
1456 TICKET PRINTING and NUMBERING MACHINES. P Hooker.
1463 APPARATUS for HEATING COMPRESSED AIR EMPLOYED for MOTIVE POWER ENGINES. W Walker.
1464 SURVEYING INSTRUMENT. J Henderson.
1468 DISTILLATION of SUBSTANCES HAVING a HIGH BOILING POINT.* C D Abel. (*The firm of Benno Jaffé and Darmstaedter*, Germany.)
1478 WATER TUBE STEAM GENERATORS. H H Lake. (*M H C Shann*, Australia.)

24th January, 1893.

1499 STARTING GEAR for FRICTION CLUTCHES. C Körte.
1501 WATER METERS. A J Boult. (*T Derichs*, Belgium.)
1502 ELECTROLYTIC PRODUCTION of POROUS FINELY-SUBDIVIDED LEAD for USE in SECONDARY BATTERIES.* W P Thompson. (*E Correns*, Germany.)
1506 VARIABLE EXPANSION SLIDE VALVES for STEAM ENGINES.* H Aderhold.
1512 BRAKE MECHANISM for RAILWAY VEHICLES. L Roberts.
1514 BONNET or GUARD for BOILER FUNNELS. R Birtwistle and J Chew.
1515 INCREASING the SAFETY of WATERTIGHT COMPARTMENTS of VESSELS. A C Smethurst.
1519 TRAMWAY POINTS. W Fowler and S Robinson.
1527 WATER HEATERS or ECONOMISERS. E Partington and E C Mills.
1528 ELECTRICAL INSULATION of WIRES. W Moseley and E Oldenbourg.
1529 GEAR for the UTILISATION of CENTRIFUGAL FORCE and MOMENTUM. S Shiel.
1535 SCREW PROPELLERS. G Chapman.
1536 STEAM ENGINES. R Bruce and R S Stranack.
1539 ARC LAMPS. C A Pfluger.
1540 HOLLOW METALLIC RIMS for the WHEELS of VELOCIPEDES and WHEEL CARRIAGES. The Star Tube Company Limited and J H Aston.
1542 DRIVING CHAINS. G L Morris.
1545 SELF-SUSTAINING MACHINERY for LIFTING and LOWERING WEIGHTS.* E W Sant.
1548 UNIVERSAL TUBE ROLLING MILL.* W L Wise. (*B Butterworth* and *W Heckert*, United States.)
1554 MOTIVE POWER MACHINE. H Forster.
1556 ATTACHMENTS for LATHES.* H H Lake. (*Ole G Noble*, United States.)
1557 SPEAKING TUBES. J E Walker.
1559 CHAINS.* L Herman.
1561 DYNAMO ELECTRIC MACHINES or ELECTRIC MOTORS.* H H Lake. (*R Lundell* and *E H Johnson*, United States.)
1566 STEAM ENGINES.* H H Lake. (*F C Weir*, United States.)
1574 CURRENT ADAPTERS for INCANDESCENT ELECTRIC LIGHT CIRCUITS. J C Fell. (*A F Vetter*, United States.)
1576 APPARATUS for STOPPING ENGINES. F D Taylor.
1579 ELECTRIC BELLS. L G Weygang.
1583 SIGNALS for RAILWAYS. R B Eggar.
1585 CHOKING COILS. J Kent and others.
1589 GUIDES for STAMP MILLS. E Major.
1590 MOTORS. F W Clark.
1592 MEANS for the PRODUCTION ELECTRICALLY of SPECTACULAR EFFECTS. A L Fyfe.
1593 STEAM BOILERS.* C W Hullings.
1595 CARRIAGE ATTACHMENTS or DIAL INDICATORS and ELECTRIC LIGHT FITTINGS. P Jensen. (*A M Blake*, United States.)
1599 SCREWS. R H Pond.

25th January, 1893.

1602 STEAM GENERATOR. C T M'Lellan.
1610 ELECTRIC HEATING APPARATUS. Sir D L Salomons, Bart.
1615 ELECTRICAL ACCUMULATORS. N S Hill. (*I Nicolariff*, Russia.)
1620 REGULABLE ELECTRIC LAMP.* G Hall and J de Marr.
1621 SYSTEM of DISTRIBUTION for POLYPHASE ALTERNATING CURRENTS. C S Bradley.
1622 FURNACE and SIMILAR BARS.* H and S Newby.
1624 AUTOMATICALLY COMPENSATING RAILWAY SIGNAL WIRES. F B Hart.
1625 APPLICATION and GENERATION of POWER TO and IN PRIME MOVERS. J Lindley and G E Sutcliffe.
1630 IRON BOWL COMPASS. W Brabyn.
1642 OBTAINING and ACCUMULATING the MOTIVE POWER RESULTING FROM the ROLLING and PITCHING of VESSELS. P Medaeto.
1648 SAFETY HEAD COVERING, FILLED WITH COMPRESSED AIR or GAS, for the PURPOSE of RESISTING or AVERTING the FORCE of a BLOW, FALL, ETC. J Ayres and others.
1651 STEAM BOILER FURNACES. A D Bell.
1663 BALL BEARINGS for SPINDLES and SHAFTS. W Hillman.
1666 APPARATUS for PURIFYING FEEDWATER. J Stevens.
1667 MECHANISM CONNECTED WITH the GEARING of MACHINE BELTING. E A A Weerth.
1673 SLIDE VALVES. J Marshall and R Wigram.
1674 CALIPERS for the MEASUREMENT of the THICKNESS of PIPES and PLATES. H J Gooch.
1675 TREATING the EFFLUENT from ELECTROLYTICALLY or CHEMICALLY PURIFIED SEWAGE for NEUTRALISING ITS ALKALINITY, and for the PRODUCTION of BYE-PRODUCTS THEREFROM. W Webster.
1676 APPARATUS for FILTERING and PURIFYING WATER. W Webster.
1680 SHEET METAL EDGING, ROLLED UP INTO a CYLINDRICAL FORM. F & S G Wilcken.
1681 APPARATUS for BREAKING UP ICE, and REMOVING or DISPLACING the SAME in CANALS, RIVERS, ETC. P G Shadbolt.
1683 ELECTRIC ARC LAMPS. F G Lott.
1687 BOTTLE-FORMING MACHINES.* H H Lake. (*R T Beckett*, United States.)
1690 SUGAR-CANE MILLS. G Fletcher. (*J Pickering*, Australia.)
1701 PLUGS or VALVES for REGULATING and for SHUTTING OFF WATER, GAS, ETC., WHILE EFFECTING REPAIRS. J E Baldwin.
1702 PETROLEUM, GAS, and OTHER VAPOUR ENGINES. J Day and L Sterne.
1703 SAWS. T B Blow.
1704 SAW FILING or SHARPENING MACHINES. R Fleck.
1710 PERFORATING TOOLS. J Opratko and A Kasalicky.

26th January, 1893.

1719 ADJUSTABLE DRAWING-BOARD FRAME. R Holmes.
1723 CYLINDERS of COMPOUND or MULTIPLE CYLINDER STEAM or COMPRESSED AIR ENGINES. W Akhurst.
1729 INSTRUMENT for DELINEATING CURVES of the LINK MOTION and OTHER CURVES. W and W E Brennand.
1739 INTERNAL FURNACES of STEAM GENERATORS. J Schofield.
1741 LUBRICATING the CYLINDERS of MARINE ENGINES AUTOMATICALLY. J F Kitching.
1743 PORTABLE UNIVERSAL RADIAL DRILLING MACHINE. A E Berry.
1745 VARYING SPEED MOTION. C J Boyce and W March.
1747 REDUCING VALVES for STEAM and LIKE ELASTIC FLUIDS. J E L Ogden.
1755 REFRIGERATING APPARATUS. J Wotherspoon.
1759 ELECTRICAL APPARATUS for USE in SHIPS' TELEGRAPHS.* G F Flemmich.
1761 OIL ENGINES. J E H Gordon.
1767 PROPELLING and DIRECTING AIR SHIPS. C Chaigneau.
1772 PROTECTING the ENDS of BOILER TUBES and TUBE PLATES FROM EXCESSIVE HEAT.* J Baldwin and J Partington.
1777 SCREW-DOWN VALVES, DRAW-OFF COCKS, and OTHER VALVES or TAPS. W Golle.
1778 COATING of ARTICLES WITH ALLOYS by ELECTRO-DEPOSITION. The London Metallurgical Company Limited and S O Cowper-Coles.
1780 FILTERING APPARATUS. H J E Jensen.
1781 RAILWAY SIGNALLING APPARATUS. E Russell.
1795 COMPOUND STEEL INGOTS. S and S R Chatwood.
1797 MACHINERY for WORKING COAL or OTHER MINERAL. C W Atkinson.

27th January, 1893.

1801 ANTI-INCRUSTATION PREPARATION for STEAM BOILERS. R M Bryant.
1803 DIVIDERS. H A Matear.
1810 AIR COMPRESSORS. A Smallwood and H Fenney.
1811 SAND BLAST APPARATUS. A Smallwood and H Fenney.
1812 ELECTRIC-LIGHT REGULATING SWITCHES. R J Sansome and H Hawes.
1822 SCREW PROPELLER SHAFTS. H MacColl.
1826 MILLING MACHINES for ENGRAVING PLATES or CYLINDERS.* W Paterson.
1829 ELECTRICAL TRANSMITTERS. W A M Brown.
1833 BUSHES for JOURNAL BEARINGS. W and G Clark.
1836 SCREW CHASERS. C S and D G M Walker.
1839 SIGHT-FEED LUBRICATORS. J M McMurtrie. (*H Murray* and *A Paterson*, India.)
1840 ELECTRIC SIGNALLING on RAILWAYS. T E Dean.
1849 TWO-WAY ELECTRIC SWITCH. A S Giles.
1860 APPARATUS for HEATING RAILWAY TRAINS and for REGULATING the LIGHTING and for SIGNALLING on RAILWAY TRAINS. J A F Aspinall and H A Hoy.
1861 SELF-CLOSING GAS BURNERS.* H H Lake. (*E F Angell*, United States.)
1863 INSULATORS USED in ELECTRIC LIGHTING. H L Doulton.
1867 PROPELLING APPARATUS for SHIPS. T Armstrong.
1870 WATER GAUGES.* R Klinger.
1880 PULLEYS.* J R Thame and R W James.
1881 HYDRAULIC FORGING PRESSES and ACCUMULATORS ESPECIALLY for FORGING CROSSING GROOVES in RAILWAY or TRAMWAY RAILS.* A H Tyler and J S E de Vesian.

28th January, 1893.

1892 VOLTMETERS and AMMETERS. R A Wormell.
1894 SELF-REGULATING DYNAMO ELECTRIC GENERATORS and MOTORS. I A Timmis and A I Smith.
1895 PROCURING a "DEAD-BEAT ACTION" of a COIL or COILS of WIRE, SUSPENDED and MOVING HORIZONTALLY or VERTICALLY in a MAGNETIC or ELECTRO-MAGNETIC FIELD of FORCE. T Clark and W B Redgrave.
1898 STEAM BOILERS. W J Parkyn.
1902 METALLIC JUNCTION BOXES for CONCENTRIC ELECTRIC CONDUCTORS. H A Mavor and others.
1903 ROTARY MOTOR. R Sutcliffe.
1906 COATING IRON and STEEL with BRASS. A V C Fenby and others.
1915 AUTOMATIC RAILWAY POINTSMAN TIME SIGNAL, and BLOCK. B Fairlee.
1917 DRIVING PULLEYS or DRUMS. G W Elliott.
1932 COCK or VALVE. E Perrett.
1936 COUPLING DEVICE for the ROLLING STOCK of RAILWAYS and TRAMWAYS. J Breckin.
1948 SECONDARY VOLTAIC BATTERIES. H Imray. (*La Société Anonyme pour le travail électrique des metaux*, France.)

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FRIDAY, FEBRUARY 17TH, 1893.

A New Electric Tramway System.

WHILST electrical engineers in Europe have up to the present been unable to make commercially successful tramcars operated on the accumulator system, and have to a certain extent abandoned that method, the Americans have been devoting more attention to the subject, with the result that various forms of storage-battery cars are being tested in the United States. The latest method—and which, it is said, is to be introduced in England by a company organised for the purpose—is termed the Acme system, and a car equipped on this principle was recently tested in New York. The Acme cell weighs 27lb. as compared with 40lb. for a cell of the same dimensions using lead grids. The grids are of a non-conducting material, which, it is claimed, is not attacked by the acid, and which is sufficiently elastic to yield to the expansion of the active material without buckling, warping or breaking. The active material, on the other hand, is retained with sufficient firmness in contact with the conducting lead plate, which is placed in the middle of the complete plate. An equal amount of active material is arranged on each side of this lead conducting plate, thus ensuring an equal distribution of current. Ribs on the non conducting grids meet through slots in the conducting plate and are cemented together, uniting the whole into one solid plate. The openings for the reception of the active material are smaller on the outside, so as to aid in the retention of their contents. The exposed surface of active material is about 40 sq. in. on each plate, or 200 sq. in. for the five positives. At the trial mentioned above, the car was equipped with 144 of these cells, carried under the seats in the usual manner, and fitted with a McDougall motor of 20H.P. The battery weighed 35cwt., the power named driving the car at seven miles an hour for three hours. Compared with methods tested in England, we fail to see, both as regards the weight of the battery and the period of three hours' running before the cells are exhausted, that the Acme system is superior to any of the former. At all events, it will be as well to await the introduction of the system in this country before expressing a definite opinion; and if the Americans can teach us something more than we know about accumulator traction, we shall be glad to learn. But it is not everything in the States which "licks creation."

Experiments with Ammonite.

A DEMONSTRATION of the capabilities of the new explosive, ammonite, was given recently near Birmingham. Ammonite, it may be explained, consists of pure ammonium-nitrate and nitro-naphthaline, and its chief recommendation is that it is a perfectly safe explosive to work with, although it is extremely powerful; indeed, it is claimed for it that it is considerably stronger than dynamite. That it is a safe explosive was clearly shown by Mr. Thomas Johnson, of Dudley, who conducted the experiments. In the presence of the company he threw a considerable quantity upon the fire, and the only result was a harmless flash, while he afterwards placed a quantity upon an anvil and struck it with a heavy hammer, showing that it was unaffected by percussion. He explained that the substance could only be exploded through the agency of a detonating cap loaded with fulminate of mercury. A quantity equal to that which was thrown into the fire and put upon the anvil produced a considerable explosion when a cap was used, and scattered the earth on which it was thrown in all directions. The explosive is packed in damp-proof metal cases greatly resembling an ordinary colour tube, and these cartridges when supplied do not contain the cap which transforms the apparently harmless composition into a most powerful explosive. The loading is performed by the user, and can be quickly and expeditiously carried out. A nipple at the top of the cartridge is pinched off, the cap is inserted, the fuse is made fast, and the explosive is ready for use. An 8oz. cartridge so prepared was thrown into a pool of water at the bottom of the clayhole, and the explosion that followed caused a tremendous disturbance, a spray of water being thrown up fully 50ft. into the air. Holes were afterwards bored in the face of a solid wall of clay and three cartridges fired, with the result that a large body of clay was thrown down and a great quantity loosened. In this instance the borings, 5ft. deep, were made straight into the clay, and some large pieces were hurled for nearly 100 yards. A second experiment was made with the boring at an angle, and one cartridge only was fired. A large quantity of clay was dislodged, and the force of the explosion was seen by huge cracks which ran in all directions across the face of the clay wall.

Electric-light Companies.

IT is a matter for congratulation that most of the metropolitan electric-light companies are gradually being placed in a fairly prosperous condition, and that they are becoming remunerative undertakings to the shareholders. The time was when it could hardly be said that the return to the proprietors was paid out of net earnings, but a very different state of affairs now prevails. We mentioned recently that the St. James's and Pall Mall Electric-light Company, after providing for the interest on the preference capital, had yielded for last year a dividend of $7\frac{1}{2}$ per cent. on the ordinary shares. The company has a wealthy district to supply, at least as far as customers are concerned, and this accounts for the prosperous condition of the company. It is, however, now proposed to further extend the lighting, and for this purpose the new generating station is now being rapidly got ready; and as an inducement to the adoption of electrical illumination, the price of current per Board of Trade unit has been reduced from 7d. to 6d. per unit. The Kensington and Knightsbridge Electric-lighting Company, whose annual meeting takes place this week, also comes forward with a fairly good return—namely, 4 per cent. per annum on the ordinary shares for 1892. The company now supplies 47,500 lamps of 8C.P., or their equivalent, as compared with 38,400 at the close of 1891. It is expected that the position of the company will be materially improved by the transfer to it of a district now served by another company. Another instance of the progress is that of the Westminster Electric Supply Corporation, which has also reduced the price per unit from 8d. to 7d. Lamps to the extent of nearly 103,000 of 8C.P. are now connected to the mains, as against 98,700 at the end of 1891. The dividend for last year is at the rate of $3\frac{1}{2}$ per cent. It will be evident that electric-light companies are becoming remunerative undertakings; and with the extension in the use of current for illuminating purposes, and the possible introduction of electric motors, the prospects should considerably improve. Dividends paid out of net receipts from current sold will do much to convince the public that the electric light is highly appreciated, and that the industry now rests upon a sound basis.

Electricity Displaces Steam Power.

AN electric generating station has recently been started at Bockenheim, in Germany, on the Lahmeyer rotary current system. It differs essentially from all central stations, in Europe at least, since it furnishes the greater portion of the current for motive-power purposes, and only a small quantity for producing light, whilst in almost every other case the reverse holds good. The station is a municipal undertaking, and current is supplied for the operation of motors at the rate of 1s. 8d. per effective horse-power of the motors. The motors are connected direct to the high-tension mains, whilst incandescent lighting is carried out by the use of transformers converting the rotary into a low-pressure continuous current. Most of the large works, remarks a Berlin electrical journal, have abandoned the use of steam engines, and have adopted electric motors in their place. This is, no doubt, due to the low charge per horse-power, and to the reduction in the expenses incidental to keeping boilers under steam for hours when not required.

Boiler Explosions in 1891-92.

THE report to the Secretary of the Board of Trade on boiler explosions during the twelve months ended June 30, 1892, which has just been issued, shows that preliminary inquiries or formal investigations under the provisions of the Boiler Explosions Acts, 1882 and 1890, were held in 88 cases during the period stated. This is the largest number of cases dealt with in any year since the Act of 1882 came into operation, but the number of lives lost (23) was below the average (29·6) for the nine preceding years. In 46 cases the boilers which exploded were in use on land, and in 42 cases on board vessels. In 32 cases formal investigations were held. In more than half these cases the owners of boilers were blamed for neglect, for reckless management, or for the employment of incompetent or inexperienced persons. In most of the cases the persons blamed were ordered to pay the costs of the inquiry or a portion of them. The commissioners usually attached responsibility to the owner of the boiler, whether the negligence which led to the explosion was shown by himself personally or by his servants. In two cases the makers of the boilers were ordered to pay the costs for misrepresenting the working pressure at which the boilers could be safely worked, and in one instance a person who voluntarily and ignorantly undertook to advise the owner on the same points was also ordered to pay costs. In another instance an engineer who sold the boiler to the owner without examining it was ordered to pay costs. In one case only was an order made against a boiler insurance company on account of negligent inspection, and it may be inferred that on the whole the examinations made on behalf of these companies have been efficiently conducted. "Thus far, the report says, "the results of the working of the Boiler Explosions Acts do not tend to show that careless management of boilers is on the increase. Although the total number of cases of all kinds dealt with is higher than in past years, it must be remembered that every year the requirements of the law as regards reporting explosions are becoming more widely known, and that, although the number of boilers in use is probably becoming greater in each succeeding year, the actual loss of life and the number of grave cases dealt with show no tendency to increase.

The Transmission of Power by Compressed Air.

(*Continued from page* 57.)

HAVING now arrived at the general defects of air compressors, let us see by what means they can be removed.

First let the abstraction of heat occupy our attention. It has been shown that mere contact of air with the surface of the cylinder, though the latter may be efficiently cooled by water outside, is not sufficient to abstract a very large proportion of the heat of compression. Taking the adiabatic curve for air to be expressed by the formula

$$P V^{1 \cdot 408} = \text{a constant,}$$

the writer has found that the actual curve obtained from compressors with jacket cooling only, and for ordinary air, which always contains a proportion of aqueous vapour, seldom comes below

$$P V^{1 \cdot 3} = \text{a constant.}$$

The introduction of water during the suction stroke has very little effect indeed, as might be expected when it is remembered that it would fall in a body to the bottom of the cylinder, and any cooling that could result afterwards would be due to conduction of heat downwards, a condition under which water takes up heat very slowly. The method of pulverising the water through nozzles during the compression stroke has already been described, and is the only effectual way of cooling in the cylinder. But there is a way which has been known since very early in this century, but which has only during recent years been applied to moderate pressure. That is the compression in stages with intermediate cooling. This is the only way which allows of complete cooling, and it is carried out in the following manner:—

The whole of the air is drawn into a low-pressure cylinder, and is there compressed up to 20 or 30lb. per square inch above the atmospheric pressure, the exact relationship between initial, intermediate, and final pressures being given by the formula

$$P_1 = \sqrt{P_0 P_2}$$

where P_0 is the atmospheric pressure, P_1 that of the intermediate receiver, and P_2 the final pressure—absolute pressures in all cases being used. On leaving the low-pressure cylinder the air, which has become heated to a certain extent, passes into an intermediate receiver and is cooled down to its original temperature either by means of a spray of water or by passing through tubes surrounded by cold water. The air then enters a smaller or high-pressure cylinder, in which the pressure is increased up to that desired. Fig. 3 is what may be called an ideal combined diagram from two such cylinders. Assuming that the cooling is done by a jacket only, the area E F D K E shows the best result that could usually be expected from a compressor doing the work in the usual way in one cylinder. When two cylinders are employed the compression curve follows the same line up to the point L, when delivery from the low-pressure cylinder commences. The air then passes through the cooler, during which time its volume is reduced by the abstraction of heat until it reaches the isothermal line at M; compression then takes place in the smaller cylinder, and the curve follows the 1·3 line again until the delivery pressure is reached. The amount of saving due to the intermediate cooling is shown by the area which has been cross-sectioned. But beyond this there is another important point to be noticed, and that is the influence of compounding on the clearances at the end of the stroke, supposing for the present that no means for reducing their effect is adopted. If the compression took place in one cylinder the effect of a 2 per cent. clearance in compressing to 5 atmospheres absolute would be to reduce the effective stroke about 8 per cent., while a 2 per cent. clearance on the low-pressure cylinder, in

which the absolute delivery pressure for the same final pressure would be 33·09lb. per square inch, would be about 2·5 per cent. That, gentlemen, is a very considerable gain, for it must not be overlooked that whatever air passes through the first cylinder must pass through the second, whatever the clearance spaces in the latter may be. There would, of course, be a drawback if the high-pressure clearance spaces were excessive, for then the intermediate receiver pressure would be higher than desirable, with the result that the power expanded in the low-pressure cylinder would be greater than the most economical amount. As will be seen from the calculation in the appendix, the formula

$$P_1 = \sqrt{P_0 P_2}$$

is made to satisfy the condition that the heat generated shall be a minimum, and that condition bears with it the further conditions:—

1. That the amount of heat generated in each cylinder is equal.
2. That the power expended in each cylinder is also equal.

As an illustration of the difference of temperature in the two cases of simple and compound compression, it might be interesting to remark that with dry air, and with jacket cooling, the final temperature with 73·5lb. absolute pressure in the re-receiver would be:

$$\frac{T}{T} = \left(\frac{P_1}{P_0}\right)^{\frac{n-1}{n}} \quad T = 521 \left(\frac{73 \cdot 5}{14 \cdot 7}\right)^{\frac{1 \cdot 3 - 1}{1 \cdot 3}} = 293^\circ \text{ F.},$$

while with the compound compression it would be:

$$T = 521 \left(\frac{P_1}{P_0}\right)^{0 \cdot 23} = 175^\circ \text{ F}$$

$$T = 521 \left(\frac{P_2}{P_1}\right)^{0 \cdot 23} = 175^\circ \text{ F.}$$

Probably the most important application of this principle is that which has been carried out in Paris, by Professor Riedler, on a very large scale. Every care is taken both with the valves and with the cooling arrangements, and the result is that the actual indicator diagrams of the air cylinders exceed the isothermal diagram by only 12 per cent., whereas the usual amount, even with first-class compressors of the ordinary kind, is a waste of upwards of 40 per cent.—that is to say, the area of the actual diagram from the air cylinders is 40 per cent. greater than the area which should be obtained if the compressors were perfect, and the compression isothermal. In the case of the Paris compressors the cooling is done by injection of water into the low-pressure cylinder, after Colladon's method; then water is sprayed into the air during its travel through a plain cylindrical intermediate receiver, and in the high-pressure cylinder again the same operation is performed. What this result means in such an installation as that at Paris can easily be judged in the light of the following figures, which are taken from a short treatise by Professor Riedler, entitled "Neue Erfahrungen ueber die Kraftversorgung von Paris durch Druckluft":—

The air is compressed to a gauge pressure of 6 atmospheres=88·2lb. per square inch, and the performance of the Dubois-François simple compressors was such that 300 cubic feet of air at atmospheric pressure and temperature could be delivered per hour into receivers, at 88·2lb. pressure, for the expenditure of 1I.H.P. in the steam cylinders. The Riedler compound compressors delivered, under the same conditions, 367 cubic feet of air measured at atmospheric pressure and temperature—a result 22½ per cent. better for the same expenditure of fuel, etc.

The reduction of the effect of the clearance spaces can be carried out in a variety of ways, though the principle is the same. Supposing the piston to be nearly approaching the end of its stroke, there will be on one side of the piston air in the clearance spaces at the receiver pressure, while the other side of the piston will only have, at most, the atmospheric pressure. Now, if the suction valves could be closed immediately before the end of the stroke, and a connection be made for a short time between the two sides of the piston, so that the high-pressure air in the clearance spaces could flow into the suction side and be expanded down until there was an equilibrium on both sides, it is clear that the pressure in the suction side would rise above that of the atmosphere in proportion to the volume of the clearance, and a large proportion of the air from the clearance spaces would be entrapped and delivered on the return stroke.

Various ways of arriving at such an end will suggest themselves, but perhaps the simplest is to cut or cast short grooves at each end of the cylinder, of such a length as to allow the air from the idle spaces to pass behind the piston rings from one side to the other of the piston. By such means, and with ordinary pressures, the actual delivery of air can be made to reach in daily practice 95 per cent. of the theoretical capacity of the pump, after the effect of the alteration of temperature has been allowed for, and the volume corrected to, say, 60° F. Special stress should be laid upon the correction for temperature, because the results which can be produced by very bad compressors in getting up pressure in receivers are very startling until questions of increase of volume from high temperature receive due consideration.

Automatic-acting suction and delivery valves seem to have been the rule from earliest times; but mechanical difficulties, principally with delivery valves, convinced the writer some years ago that greater perfection was desirable, and a careful study of the problem led him to the conclusion that unless the valves could be governed at least during the closing period, a sufficiently large area of opening could not be attained. The outcome of this conclusion was a trial of an ordinary mushroom valve, opened by a cam, and prevented from closing too rapidly by the same cam. This valve, though lifting fully one-quarter of the diameter of the seating, closes without the least noise, and answers its purpose admirably. It will be understood that the valve is free to open of itself before the cam reaches the lifting lever, so as to suit lower pressures than the maximum. The delivery line of the indicator diagram can thus be made to coincide with the line of receiver pressure, and thus another fruitful source of loss is overcome; while the results as regards durability will undoubtedly be good, owing to the quiet working of the valve.

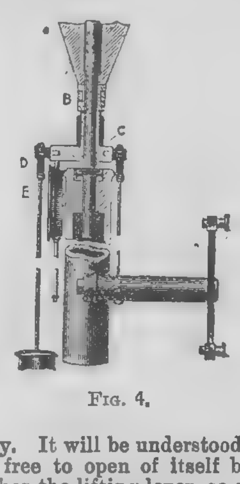


Fig. 4.

Professor Riedler appears to have come to a similar conclusion as to the necessity for governing the action of the valves, for he provides means for manipulating both those for suction and those for delivery.

His valves are provided with springs or other means for giving them a tendency to open, and when the proper time for closing has arrived, the mechanism closes them either by a direct action or by the application of a loading spring. Valve resistances are thus reduced to a minimum.

Having so far dealt with the compressor, it might be well to speak of its efficiency before proceeding to the next part of the subject. This course has one particular thing to recommend it, and that is its similarity to the course pursued almost invariably by electricians when dealing with a similar subject. From repeated tests it is known that the mechanical efficiency of an air compressor seldom falls below 87 per cent. after a few weeks' working, and a two-stage compressor can be relied upon to give an efficiency of compression of at least 86 per cent.; therefore, for every 100I.H.P. developed in the steam cylinders, we can count upon getting the equivalent of

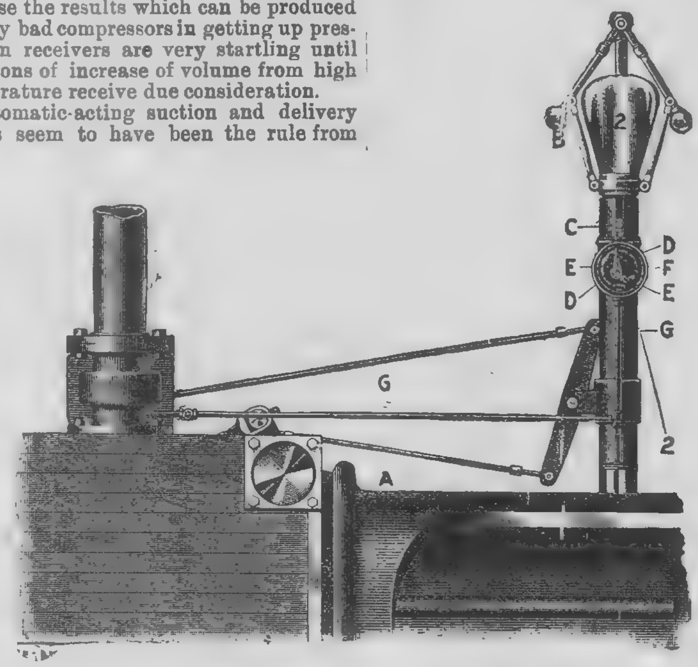
$$\frac{86 \times 87}{100} = 75\text{H.P.}$$

in the air when cooled to atmospheric temperature in the receiver. This is a reasonable working result with dry compressors. Better results have undoubtedly been reached in regular working, and better results still have been published, but it is very questionable if the latter could be produced if tests were made of reasonable duration by competent persons.

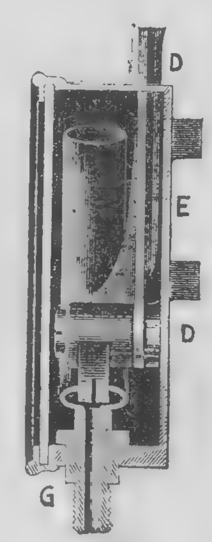
(*To be continued.*)

Care should be taken to see that every advertisement expresses a business idea clearly and definitely, so as to be easily remembered. It should be conspicuous, and care should be taken to see that under all circumstances this latter quality is maintained.

Automatic Safety Governor Stop.



Automatic Safety Governor Stop.—Fig 1.



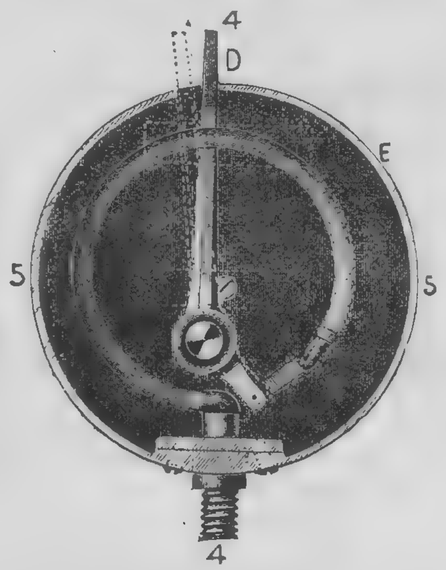


Fig. 2. Automatic Safety Governor Stop. Fig. 3.

This invention relates to governors for engines, and especially to those of the Corliss type. Its object is to provide a safety stop for engine governors which is simple and durable in construction, effective and automatic in operation, and arranged to permit the governor, in case of accident, to drop sufficiently to throw the cam on the knock-off levers into action to prevent the cylinder from taking steam.

It is so arranged that it can be attached to any Corliss governor, in any position, so that the lever of the stop supports the weight of the governor.

The device consists of a stop controlled by the steam, and adapted to support the governor sleeve when the steam is shut off.

Fig. 1 is a side elevation of the improvement as applied. Fig. 2 is an enlarged transverse section of the same on the line 2-2 of Fig. 1. Fig. 3 is an enlarged face view of the stop. Fig. 4 is a transverse section of the same on the line 4-4 of Fig. 3.

The engine A is provided with the usual governor B, or any other governor, connected with the valve mechanism of a Corliss type of engine, or with the valve stem of throttling governors. The governor B is provided with its usual sleeve C, adapted to rest on a stop preferably made in the shape of a lever D when the steam is shut off by the engineer. When, however, an accident happens to the governor while the engine is running, the stop D, being a distance below the sleeve C, permits the governor to drop sufficiently to completely shut off the steam from the engine.

It is understood that the stop lever D supports the sleeve when the steam is shut off by the engineer closing the valve. Then the valves of the engine are still in position to take steam as soon as the engineer again opens the valve to start the engine. This stop lever D is controlled by the steam, and for this purpose the following arrangement is made. The lever D is fulcrumed within a casing E, attached to the support of the governor, as shown in Fig. 1. The lever D is provided with an extension pivotally connected by a link with the closed end of a spring tube F, preferably bent in the shape of a segment of a circle, as shown in Figs. 1 and 3. The spring tube F is arranged within the casing E, and is connected at its open end with a pipe G, leading to the supply pipe or other part of the steam chest, so that the steam can enter the said pipe G whenever the valve controlling the inlet of the steam through the inlet pipe is opened.

It will now be seen that when the steam passes through the pipe G into the tube F, the latter swings outward at its free end, as shown in dotted lines in Fig. 3, thus exerting with this free end a pull in the extension of the lever D, whereby the latter swings from under the sleeve C, to permit the latter to drop below its normal position in case of accident to the governor. As soon as the steam is cut off from the pipe G, by closing the valve in the inlet pipe to the cylinder, then the tube F is relieved of the pressure of the steam, and consequently its free end contracts so as to move the lever D back to its normal vertical position, as illustrated in Fig. 3, to support the sleeve C in a normal position.

It will be observed that while the engine is running the lever D is swung from under the sleeve C by the pressure of the steam in the spring tube F, so that in case of accident to the governor B, the latter can drop sufficiently to throw the cams on the knock-off levers into action, so that the steam hooks cannot catch and open the valves, thus cutting off the steam supply and stopping the engine.

When the engine is running normally and the lever D has swung from under the sleeve C, as above mentioned, and steam is shut off from the supply pipe, the lever D swings back into its normal position before the engine comes to a stop, so that D is ready to receive and support the sleeve C, thus holding the governor in the proper position for starting the engine.

The makers are the Sioux City Engine Works, Sioux City, Ia., U.S.A.

Wrought Iron.

Mr. T. Turner gave the third lecture on "Wrought Iron," at Mason College, Birmingham, on the 10th inst. The puddling process, he said, was essentially an English process, being invented in its original form by Cort in 1784, and practically all the important improvements since introduced have been due to British enterprise. The original furnace was wasteful owing to the sand used for the furnace bottom. This was replaced by a cast-iron plate covered with

cinder, by Rogers, in 1818, and the modern process of puddling was invented by J. Hall, of Bloomfield, Staffordshire, about 1830. In the process as now conducted, the impurities of the iron are removed by means of oxygen supplied in the form of oxide of iron used for fettling the furnace, and a corresponding quantity of iron is obtained from this source and added to the charge. The modern process is thus more rapid and more economical, and the success, so far as the chemical aspects are concerned, depends upon the proper proportion of the oxygen of the fettling to the impurities of the iron. If the iron is too impure, or, as it is called, "hungry," much waste of fettling results, and the product is inferior; while, again, if the fettling is very rich and the iron good, the charge works very dry and metal has to be burned, and so wasted, to make the necessary slag. But, even under the most favourable conditions, much must always depend upon the care and attention of the puddler, and any want of skill or neglect on his part leads to inferior results.

The lecture was illustrated by means of a number of photographs of local ironworks.

Mechanical and Engineering Drawing.—VI.

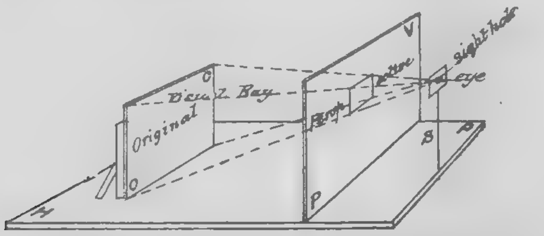
By a Practical Draughtsman.

Mechanical and Freehand Drawing: Their Difference and Uses.—Before proceeding with an exposition of the principles on which the practice of mechanical drawing is based, it is necessary that the student—who is assumed to have no previous knowledge of the subject—should thoroughly understand the radical difference, in character and application, which exists between it and that kind of drawing known as "freehand."

The generic term "drawing," strictly speaking, is the art of representing objects on a surface—generally flat—by means of *lines* showing their forms and general contour, independent of colour or shading; for the latter, without form, would be meaningless and incapable of expressing anything. Freehand drawing is the practice of the art of drawing by means of the hand, the eye alone controlling and guiding the tool or instrument used for delineation. The hand guided by the eye can, however, only picture or draw what is seen from *one position* at a time; for were it otherwise, a distorted view of the object would be the result, as its *appearance* to the eye from one point of view would be different to that from any other.

All objects are made visible to the sense of seeing by the agency of *light*, whether natural or artificial, for without light it would be impossible to distinguish one object from another. To the artist or draughtsman, light is a stream of matter given off by a luminous body, travelling from its source in thin straight lines—or *rays*—to the object illumined, from which it is reflected or transmitted in the same way to his eye. What is seen, or is apparent to his sense of sight, he depicts or draws on his paper. If he changes his position with respect to the illumined object, he sees it differently, and obtains a different view of it; each such view, if correctly drawn, is known as a "perspective," and would agree with that obtained in the following manner.

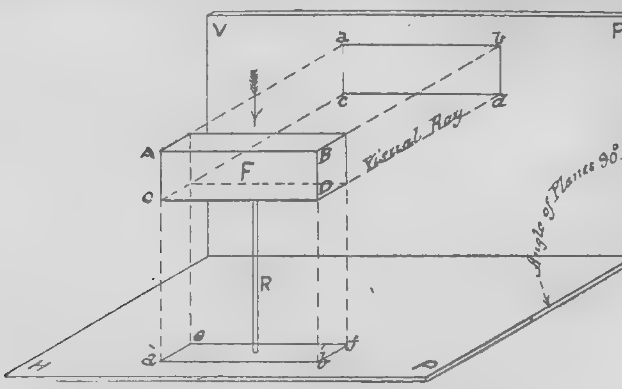
In the diagram (Fig. 12) let H P represent a flat surface, such as a piece of ground or a floor, exposed to sunlight, and V P a sheet of glass set up on H P in a vertical position. At any distance to the left of V P and parallel to it is erected a piece of fencing O O having its top and bottom edges parallel to H P and its side edges perpendicular to it. At a given distance to the right of V P, and perpendicular to H P, a staff S, surmounted by a small rectangular plate of any opaque material, and pierced with a sight hole, is fixed, the height of this sight hole from H P being supposed to equal that of an observer's eye from the ground. The sheet of glass V P being transparent, it is evident that the spectator, on looking through the sight hole, will see the whole of the piece of fencing, and can judge of its *appearance* from the *position* occupied by his eye. If he wished for a record of this appearance he can obtain it by drawing on the glass what he sees through the sight hole. The view he would get would be a perspective of the original object O O, or the fence. But its contour or outline on the glass, although similar, would be much smaller than its original. How much smaller, would entirely depend upon the distance between the eye at sight hole, the sheet of glass V P, and the fencing O O. It is evident that the nearer V P is to O O, the eye remaining in the same position, the larger would be its image or picture upon V P, and the converse of this would obtain were the conditions reversed.



Mechanical and Engineering Drawing.—Fig. 12.

It will be seen from the diagram that the perspective view of the original object is obtained by finding where the luminous or visual rays—represented by broken lines—proceeding from its principal points, are intercepted on V P in their passage to the eye, and then joining such points by sight lines as in the original. Now, as these visual rays, or "projectors," are the means by which the view of the object is *projected* or thrown on V P, such a view is called a "projection," and in the special case we are considering a "perspective projection." In all such a delineation it is apparent that all rays proceeding from the visual points in the object form a pyramid the vertex of which is the point where they meet in the eye; and from this fact it will at once be seen that a perspective drawing of an object can serve no other practical purpose than that of showing its appearance when viewed from a certain fixed position, for its boundary lines altering with the altered position of the spectator, it is difficult to determine their *actual lengths*, as they only bear a relative proportion to their originals. As they cannot be measured with an ordinary rule or scale, it would be impossible to construct a machine or erect a building from such drawings. In perspective drawing H P in the diagram is known as the horizontal or *ground plane*, and V P the perspective or *picture plane*, which latter is always supposed to be transparent, although actually represented by the artist's sheet of drawing paper or canvas.

As, then, a perspective, or free-hand drawing, does not fulfil the requirements of the workman, in that he cannot determine at sight the actual form, dimensions, or arrangement of the piece of work he is called upon to execute, some other method of delineation becomes a necessity. This want is supplied in what is generally known as a "mechanical drawing," or a drawing obtained by the correct application of the principles of a kind of projection called "orthographic," which gives results differing widely from that already explained, in that it affords a means of at once determining the actual form, size, and disposition of every part of the object represented, and gives an adept in the application of its principles the power to commit to paper the entire design of a machine or engine, that will enable the engineer or machinist to determine at sight whether the stationary and working parts of one or the other are disposed in such a way as to meet the requirements for which they were designed. In fact, a mechanical drawing is the only efficient way of describing by means of *lines*, properly disposed according to fixed rules, the actual construction and arrangement of a piece of mechanism.



Mechanical and Engineering Drawing.—Fig. 13.

As "orthographic" projection is the basis of mechanical and engineering drawing, its difference as compared with perspective projection must be understood before the study and application of its principles are entered upon. An important consideration in connection with either kind of projection is, that the bodies, or objects, whose forms it is wished to depict on paper, are in all cases assumed to be illumined by solar light, and have the power of reflecting or throwing off the light that is cast upon them. As the source of light—or the sun—is at a comparatively *infinite* distance from all objects illumined by it, its rays will not sensibly diverge, or approach each other, but may be regarded as exactly parallel among themselves. Then if, instead of the rays from an illumined object being reflected so as to converge in the eye—as in perspective projection,—they be conceived as travelling from the object in *parallel* lines, till intercepted on a plane surface at right angles to themselves, and the points of interception be joined by straight or curved lines, the representation thus formed on that surface will be an "orthographic" projection of the original object. In this case the visual or projecting rays, being always parallel to each other and perpendicular to the surface on which they are projected, form a prism; and it follows that, however far that surface is from the object, its representation remains the same, and the projected length of all its lines parallel to that surface will be of the same length as in the original, and therefore their exact dimensions can be at once ascertained.

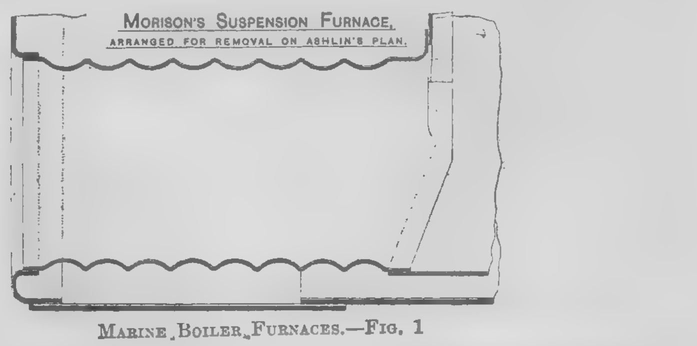
It will be understood from this explanation that instead of the eye being stationary and viewing the object from one point alone, as in perspective, it is in orthographic projection supposed to move in such a way as to be directly opposite to each of the principal points of the object, the projecting rays from it being always perpendicular to the plane on which its image is projected. It is manifest, however, that in this way only one projection of an object is obtained; but as any solid body has more than one dimension, it becomes evident that more than one view of it must be given before its other dimensions can be ascertained. To this end it is usual to determine its projections on two planes, which are always at right angles to each other, and from these correct and definite ideas as to its shape and dimensions may at once be obtained.

To illustrate the foregoing diagramatically, let H P (Fig. 13) be a horizontal plane, and V P another plane at right angles or perpendicular to H P. At any distance from V P, and in front of it, a rod R is set up perpendicular to H P, supporting on its upper end a bar F of rectangular section and a given length. Visual rays or projectors parallel among themselves and perpendicular to V P are shown proceeding from the corners A, B, C, D of the bar penetrating V P in *a*, *b*, *c*, *d*. As the edges of the original object, or the rectangular bar F, are all straight, it follows that if *a*, *b*, *c*, *d* or V P be joined by straight lines, an orthographic projection of the face A, B, C, D, of the bar will have been obtained, which will, on measurement, be found to be an exact counterpart of it. But this projection only gives the *length* and *depth* of the bar; and as it is necessary to know its other dimension, or *width*, a view showing that dimension must be obtained. Now it is evident that a view of the bar, looking at it from above and in the direction of the arrow, will supply the information required. If, then, visual rays, or projectors, proceed as before from the four corners of the face of the bar seen from above, to the plane H P below, they will penetrate that plane at the points *a'*, *b'*, *e*, *f*, and these points being joined as before—as the same conditions obtain—there is produced on H P an orthographic projection of the top face of the bar which determines its width. With these two projections, or views of the original, it will be seen that a workman could produce any number of such bars without the assistance of a model or other guide. To distinguish the two projections of the same object, the one obtained on V P is known as an "elevation" or *vertical* projection, and that obtained on H P is called a "plan" or horizontal projection.

(*To be continued.*)

Marine Boiler Furnaces.

A boiler furnace is one of the most important details in marine engineering, as it not only represents the most efficient heating surface in the boiler, but in the event of accidents its replacement or repair is highly expensive in itself, and involves the temporary disablement of the steamer.



Marine Boiler Furnaces.—Fig. 1

From the nature of the manufacture and the great expense of experimental tests, engineers generally have had less opportunity of becoming thoroughly conversant with modern furnaces than with any other detail of marine engineering, and the object of this paper is to lay before the Institution the results of some experiments which have been made, and also, by advancing certain theories resulting from actual experience, to arrive by discussion at the probable cause of the many commercially disastrous accidents of recent years.

The chief points upon which this paper will treat are:—Design, mode of manufacture, practical requirements, strength, and material.

As soon as steam of a higher pressure than that of the atmosphere began to be used it was found desirable to replace the ordinary square section furnace, with its flat sides and top, by a design theoretically stronger and less liable to collapse under pressure; consequently the cylindrical form was chosen, and, with modifications, still remains in use. When steam pressures of 100lb per sq. in. and over became general, the thickness required for a long, plain furnace was excessive, and engineers considered how it was possible to obtain the necessary strength in a more scientific manner than by increasing the thickness of the plate.

Experiments made by Fairbairn had shown that the strength of a flue under collapsing pressure varied with the length, and that short flues were stronger than long ones, so the first step taken to increase the strength of plain flues was by adding strengthening rings circumferentially, thus practically making one long flue into several short ones. At first angle or T-rings were riveted on, but as the rivets were directly exposed to the fire, a better arrangement, known as Adamson's rings, was ultimately adopted. This design consists of short plain cylindrical tubes, flanged outwards at the ends, so that two rings or more may be conveniently riveted together, the rivets being completely covered by water, and so protected from

* Abstract of a paper by D. B. Morison, of Hartlepool Engine Works, read before the North-East Coast Institution of Engineers and Shipbuilders.

the fire. The method of manufacture of flues constructed with Adamson's rings is so well known that further explanation is unnecessary, and although marine engineers prefer a furnace with no circumferential joints, these furnaces are still fitted in high-pressure boilers, and various experimental results, which have been kindly placed at the disposal of the writer by Messrs. Hall, Russell and Co., of Aberdeen, and Messrs. J. Howden and Co., of Glasgow, will be referred to subsequently.

A great step forward was the introduction by Mr. Samson Fox of his corrugated furnace flue, the strength of which is so much in excess of that of a plain flue that it came rapidly into use and was for a considerable time almost universally adopted for high pressure boilers. Indeed, it is certain that the rapid adoption of the triple-expansion engine was due in a great measure to this invention. Corrugated furnaces were first introduced in 1879, the method of manufacture being the crude one of hammering a plain flue on a corrugated anvil block. In 1882 Mr. Samson Fox invented his rolling mill, which is still used by the Leeds Forge Company for the production of both Fox's corrugated and Morison's suspension furnaces, the latter being an improved design lately introduced. These furnaces are made from Siemens-Martin steel ingots rolled into plates of the required dimensions under ordinary plain rolls. Three sides of a plate are sheared, and on the fourth side the development of the saddle is marked and punched out. Test-pieces are taken from the scrap thus produced and tested for tensile, elongation and bending. The plate is then formed into a tube and lap-welded by water-gas, the welding by this process being so efficient that in a series of tests lately made the tensile strength across the weld was found to be but slightly less than the original plate. This welded tube is next heated in a special furnace, and is then placed in Fox's patent mill, the rolls of which are corrugated, and in order to get the tube between the rolls, the top roll is worked out and in longitudinally by hydraulic power. Complete corrugations are formed by one revolution, but a few turns are given for finishing, and the furnace is withdrawn as a perfectly cylindrical corrugated tube. Flanging is the next process, and although this has hitherto been done by hand, arrangements are being made for flanging by hydraulic pressure. This undoubtedly will be a great improvement, because of the fact that the greater the amount of work put on the back ends of furnaces of any type, the greater is the liability to crack, especially if the steel is of very high tensile strength. The furnace is now complete, the final process being annealing.

A modification of the Fox is that known as the Farnley flue, the corrugations of which are similar to those of the Fox, but instead of being at right angles to the axis they form a series of spirals, the advantage claimed being additional longitudinal rigidity.

Another step in the direction of increased practical efficiency is a design by Mr. Holmes, of Hull, the feature in this furnace being that the outward corrugations are pitched about 16in. from centre to centre, the distance between the corrugations being of plain, cylindrical section. In the Holmes furnace the corrugations are 2in. in depth, and are formed one at a time by pressing the metal between suitable dies, the furnace being revolved between each application of pressure.

The furnace which has been the greatest rival to the Fox is that known as Purves's patent, and is manufactured by Sir John Brown and Co., of Sheffield. This furnace was patented in 1880 by Mr. Purves, late of Lloyd's Registry, and consists of a series of thickened ribs 9in. between centres, the parts between the strengthening ribs being of plain, cylindrical form. A novelty in this furnace is the method of manufacture, as it is the first furnace of unequal section, and the first furnace not made from an originally plain plate of equal thickness throughout. The "Purves" flue is made from Siemens-Martin ingot. Rectangular section slabs sufficient for two flues are formed from these ingots under a 15-ton hammer, the slabs being about 7½in. thick, and their length being equal approximately to the length of the flues required. Special roughing rolls convert the slab into a ribbed plate 1½in. thick, which is then cut in two by very powerful shears, and, after reheating, each half is passed through finishing rolls until the final required thickness is obtained. At one side edge there is a piece of plain plate 15in. wide to the centre of the first rib intended for the front end of the flue, and at the other side the plain part is 23in. wide and intended for the back end of the flue, and the thickness in both these side edges is increased by ⅛in. to allow for the thinning which takes place during flanging, etc. After being sheared at the edges and the end slotted to the shape required, the plate is bent into a circular form by a special hydraulic press. The edges are then welded together by the insertion of glut pieces, the plain parts being welded first and the ribs afterwards. Annealing is the next process, and after being withdrawn from the furnace the flue is converted into a perfectly circular tube by a very ingenious hydraulic press. It is then flanged, etc., in the ordinary way, the final process being annealing.

The latest design introduced is that known as Morison's suspension furnace, which is a modification of both the Fox and Purves types, and a combination of the good features of each. It is manufactured in exactly the same way as the Fox, the same processes being employed throughout.

An ingenious arrangement (Fig. 1) for facilitating the removal and replacement of furnaces (which are flanged to meet the combustion chamber tube plate) has been devised by Mr. Ashlin, and consists in cutting away the lower half of the flanged end so that it terminates in a plane inclined at about 120° to the horizontal, and consequently the furnace, when being removed from the boiler, can be raised and tilted at its front end, thus enabling the flanged portion to be withdrawn.

REQUIREMENTS OF A FURNACE.

The apparent practical requirements of a furnace suitable for high pressures in modern marine boilers are :—

(*a*) The furnace should be such as to give it the greatest evaporative efficiency and the least mean temperature.

(*b*) The material should be so disposed as to give the greatest resistance to collapse without undue rigidity in a longitudinal direction.

(*c*) The strength of the flue should be uniform throughout its length, so as to prevent partial collapse or local sagging.

(*d*) The material should be of equal thickness, so that expansion may be uniform and not unequal and local.

(*e*) The formation should be such that the strains resulting from extreme variations of temperature should be distributed throughout the length of the furnace, and not concentrated at any point so as to induce cracking.

(*f*) There should be no narrow cavities or recesses for undue and unequal accumulation of deposit, resulting in the burning of the material, and also in decreased evaporative efficiency.

(*g*) The strengthening projections should be outwards, or towards the water space and so protected from the fire.

(*h*) The surface should be of such formation as can be easily scaled, cleaned, repaired, or replaced.

(*i*) The material of which the furnace is made should be such as has been found by experience to be reliable in manufactures and the most suitable for withstanding the extreme variations of temperature, rather than such as has the greatest tensile strength. In other words, the material should be of the best quality for standing the comparatively rough treatment of the boiler-shop, and the alternate and repeated heating and cooling of the furnace when in use, and the necessary strength should be obtained by the efficient disposition of material, thus giving suitability of material the first consideration, rather than the strength of material.

Before proceeding to consider how the furnaces under notice fulfil the requirements previously enumerated, it should be noted that the minimum steam pressure in a modern marine boiler is 160lb. per sq. in., and the tendency is to increase that pressure up to 180, and even 200lb., and also that a furnace of large diameter with a short grate is more efficient than a small diameter with a long grate; for two reasons—one being that the combustion is more perfect in the larger furnace, and the other—the practical reason—that an average fireman is able to fire a short grate better than a long one, especially in these days of limitation of work and disinclination to exert a maximum amount of energy. These considerations alone seriously detract from the value of the ordinary plain furnace, as, all other conditions being similar, it is the weakest form of cylindrical furnace at present in use; and as the greatest thickness allowed by the Board of Trade is ⅝ of an inch, the largest diameter obtainable for 180lb. with a furnace 6ft. 6in. long is 28·647in.

Lloyd's, however, allow a greater thickness, and many engineers use plain furnaces up to ⅞ of an inch; but the all-important commercial question is: Do these thick furnaces of small diameter result in the maximum obtainable efficiency in a modern steamship? And as the keen competition in shipping demands that for success attention should be given to every detail, it is necessary that a furnace should be not only the most economical for steam producing, but should be of such a formation as will last the greatest length of time and have the least prejudicial effect on the wear and tear of the boiler. The material of a furnace is subjected to greater variations of temperature than in any other part of the boiler, being greatest in amount above the grate bar and least below. Intensity of temperature above the grate bar depends on the condition of the fire, the thickness of the plate, the amount of deposit on the plate, and the steam pressure. The variations of temperature are incessant, and depend on condition of fires, opening and shutting of doors, and cleaning of fires. These variations of temperature result in expansion and contraction producing definite mechanical movement, and if the design of furnace is such that it cannot readily adapt itself to those movements (and no plain furnace can), either the material becomes distressed or such strains are produced on the boiler that leakage results. It is for this reason that excessive corrosion is often found at the grate bar level of plain furnaces, and specimen A is an illustration in which the corrosion has penetrated entirely through the plate.

The Adamson design is a considerable advance upon the plain furnace from the fact that it is less rigid in a longitudinal direction, and is stronger to resist collapse. It has, however, the objectionable feature of a series of circumferential riveted joints. This defect is removed in the Holmes furnace, which, although not introduced immediately after the Adamson, is the next step in advance of it.

The Fox furnace at the time of its introduction was the strongest form to resist collapse ever made, whilst the nature of its formation rendered it specially suitable for accommodating itself to the strains resulting from variation of temperature, and the fact that it is of uniform thickness and of uniform design caused the strains to be distributed throughout the length of the furnace. This uniform distribution of strains is the most important feature, as, if these strains are localised, accidents will ultimately result. Theoretically the Fox furnace approaches perfection; practically, however, it has defects, the chief of which is the undue accumulation of deposit in the narrow cavity formed by the inward corrugations, and as these corrugations are nearest to the fire, the material becomes unduly heated and frequently cracks. The scale in these narrow cavities is also difficult to remove and often but imperfectly removed, thus intensifying the danger of accident. These practical defects of the Fox furnace being generally recognised by engineers was undoubtedly the chief cause of the rapid adoption of the Purves design, in which not only are the supporting ribs in the water space (and so removed from the action of the fire), but there is no cavity for the undue accumulation of scale, and no greater expense incurred in scaling than with a plain furnace.

These advantages are obtained, however, at the sacrifice of others, as, all conditions being similar, the Purves flue is not so strong as the Fox to resist collapse, whilst its unequal section and longitudinal rigidity localise the strains resulting from variation of temperature, an evidence of which is the occasional development of cracks either by circumferential ripping at the base of the rib or in the vicinity of the flanges at the back end, and although this is an accident which is fortunately not common, it is sufficient to show the advantage of uniform distribution of strains. The section of the Purves flue being unequal, and the strength to resist collapse not being uniform, the first sign of collapse is the local sagging or pocketing of the flat parts between the ribs. The furnace, however, has been largely used, and it was the writer's practical experience with it which suggested the design of the Suspension furnace, the object of which was to combine those features in the Fox and Purves designs which experience has shown to be necessary for practical success, and to reject those features in each which practice has proved to be bad. The features retained from the Fox design are :—The disposition of the material in a form which gives the greatest resistance to collapse, uniform thickness and uniform strength throughout, distribution of strains uniformly throughout the length of the furnace. The features retained from the Purves flue are :—The strengthening formations are in the water space and are protected from the fire; there are no narrow cavities for the accumulation of scale, and there are equal facilities for scaling and cleaning.

(*To be continued.*)

Some Reasons for Assuming the Unity of all Physical Forces.

MATTER, by itself, has no properties: but when combined with force it develops properties. Gravity and inertia are such properties. Particles of matter are connected with each other by lines of force, and such lines tend to contract to a point, but can be strained to an indefinite length. The property of contraction on these lines of force constitutes cohesion in a mass of particles.

A large mass in a relative position to a small one constitutes gravity. A body situated at any distance from the earth's surface (or from the earth's centre) has the energy called kinetic. Its fall is caused by the contraction of the lines of force connecting it to the earth. In other words, it falls by gravity. The body was placed in its position by the expenditure of a definite force. This force was transferred to such body, and became the body's kinetic energy. When the body fell it parted with some of that energy in the shape of heat and sound. The energy was not lost, but surrendered and transferred to some other body or bodies.

Force is never destroyed or diminished; it is only interchanged. Weight is a result of the contracting lines called gravity. That same force of gravity may assume various forms, as sound, heat, light, and the electric current, and any one of them may change into the other, either in whole or in part. These forms of force are distinct from matter, and act through matter, and are the cause of all physical changes as we know them.

When a body parts with its kinetic energy it may do so in either one or a combination of forms. The electrical machine parts with the energy put into it in the form of electrical energy; a simple revolving wheel would part with it partially in the form of heat and sound.

Energy seeks the path of least resistance. The path of least resistance to electrical energy is a metal conductor. If the energy (commonly called current) is interrupted in its path, it may be caused to change into another form of energy, as sound, light, heat, chemical action, or a combination of them. It is easy, therefore, to perceive that all forces are manifestations of a single force which appears to us in various guises. The same force of gravity which causes a weight to fall will elevate another weight, or else the kinetic energy of the fallen weight will be transformed into other forms or descriptions of energy. What is lost by one body is gained by another, and by this means the equilibrium in Nature is for ever maintained.

EDMOND WOODHEAD.

Shipbuilding Notes.

Messrs. Barclay and Curle, Glasgow, have contracted to build a 3700-ton steel ship.

A new steamer, named the "Bell Rock," was launched from Messrs. R. Williamson and Sons' shipbuilding yard, Workington, on the 6th inst. The dimensions are :—Length over all, 153ft. 2in.; breadth, 23ft. 6in.; depth, 11ft. 9in. The engines will be fitted at Glasgow by Messrs. Dunsmuir and Jackson, Govan. The vessel's carrying capacity is 420 tons deadweight.

The trial trip of the steamer "Senator" took place on the 8th inst. in Belfast Lough. She was built and engined by Messrs. Workman, Clark and Co., Belfast, and is 400ft. long, her registered tonnage is 3049, and her deadweight capacity 6700 tons. Her engines are triple expansion, with cylinders 25in., 41in., and 62in. diameter. The working pressure of her boilers is 180lb., and the mean speed attained on the measured mile was fully 13 knots.

On the 6th inst. the steamer "Barrister" left the Cleveland dockyard of Sir Raylton Dixon and Co., Middlesbrough, for the customary tests of speed, etc. This vessel is the largest yet built on the Tees or at the Hartlepools, being 415ft. long, 45ft. beam, and 31ft. 3in. depth moulded, with a deadweight carrying capacity of 7000 tons. The engines have been built by Messrs. Thomas Richardson and Sons, of Hartlepool, the cylinders being 25in., 41in., and 68in. diameter, by 54in. stroke. Everything worked satisfactory during the trial.

The steamer "Rallus," after receiving extensive alterations to hull and machinery, went down the Mersey on the 6th inst. on her trial trip. She has been fitted with triple-expansion engines having cylinders 18in., 24in., and 44in. diameter, by 30in. stroke. A new steel boiler has been fitted, 15ft. 3in. by 10ft. long, with three patent furnaces. A Deane duplex pump, manufactured by the Pulsometer Engineering Company Limited, is used for feeding the boiler. On the trial, which was exceedingly satisfactory, an average speed of 11½ knots an hour was maintained, with the engines running at 81 revolutions per minute, and indicating 690H.P.

The Design and Construction of Stationary Engines.—XLVIII.

Crankshafts.—The power developed in the cylinder is ultimately transmitted through the crankshaft to the machinery to be driven, either directly by being coupled up to the machine, or by means of gearing, which latter may be either spur gear, belts, or ropes.

In locomotives the driving wheels are keyed on the shaft, and in marine engines the paddles or propellers are attached directly to the engine shaft. Such shafts are subjected to a variety of stresses. Of these the principal ones are the twisting stresses imposed by the forces acting on the crank through the connecting rod, and the bending action due to the pull and push of the connecting rod at the *dead* centres or position of maximum effort. In engines where the power is taken off by means of belts or ropes, there is also the additional stress arising from the weight of the fly-wheel and the side pull of the belts or ropes. In most cases this latter stress is neutralised by the comparatively heavy weight of the wheels.

Strength of Shafts.—The total load on the piston is transmitted to the crankpin, and exerts a twisting force on the shaft.

The moment of this force in in.-lb. is equal to the total load in lb. multiplied by the length of the crankarm in inches, and this moment is resisted by the cohesive strength of the material of the shaft.

The moment of resistance to twisting of any section is proportional to the shearing strength of the material, multiplied by a value depending on the form and dimensions of the section, and known as the *modulus* of the section for torsion. This modulus for solid and hollow shafts is given in Table XXIX.

TABLE XXIX.

Form of Section.	Modulus for Torsion.	Modulus for Bending.
Solid Circular Section, dia. = d	$\frac{\pi}{16}d^3 = \frac{d^3}{5 \cdot 1} = 0 \cdot 196 d^3$	$\frac{\pi}{32}d^3 = \frac{d^3}{10 \cdot 2} = 0 \cdot 098 d^3$
Hollow Cylindrical Section, d_1 = outside dia., d_2 = inside dia.	$\frac{\pi}{16} \times \frac{d_1^4 - d_2^4}{d_1}$	$\frac{\pi}{32} \times \frac{d_1^4 - d_2^4}{d_1}$

The diameter of a shaft to resist twisting or torsion is obtained from the following general formula, thus:—Moment of resistance = twisting moment. Let T M = torsional moment of resistance, L = length of crank in in., P = total load on crankpin in lb., d = diameter of shaft in in. Then—

$$\text{T M} = \text{P} \times \text{L} = \frac{\pi}{16}d^3 f = \frac{d^3}{5 \cdot 1 f} = 0 \cdot 196 d^3 f, \text{ and}$$

$$d^3 = \frac{\text{T M}}{f} \times 5 \cdot 1, \text{ or } d = \sqrt[3]{\frac{\text{T M}}{f}} \times 5 \cdot 1; \text{ or,}$$

$$\text{more simply, } d = \sqrt{\frac{\text{T M}}{f \times 0 \cdot 196}}$$

f = safe stress per square inch on material.

The ultimate strengths of cast iron, wrought iron and mild steel may be taken as follows:—

$$\left.\begin{array}{l} \text{Cast iron} \ldots = 24{,}000 \\ \text{Wrought iron} = 50{,}000 \\ \text{Mild steel} \ldots = 70{,}000 \end{array}\right\} \text{lb. per sq. in.,}$$

allowing a factor of safety of from 6 to 7 for wrought iron and steel. The safe stress allowable may be taken for most purposes as 8000 for wrought iron and 10,000 for steel. Adopting those values we have:—

$$d = \sqrt[3]{\frac{\text{T M}}{8000}} \times 5 \cdot 1; \text{ or, more simply,}$$

$$d = \sqrt[3]{\frac{\text{T M}}{1568}} \text{ for wrought iron, and}$$

$$d = \sqrt{\frac{\text{T M}}{10{,}000}} \times 5 \cdot 1; \text{ or, more simply,}$$

$$d = \sqrt[3]{\frac{\text{T M}}{1960}} \text{ for mild steel.}$$

The diameter for a given shaft may be calculated in terms of the horse-power transmitted. Let H.P. = indicated horse-power transmitted, p = mean pressure on crank pin in lb., π = 3·1416, r = radius of crank in feet, N = number of revolutions per minute. Then $p \times 2 \pi r \text{N} = 33{,}000 \text{H.P.}$, or

$$p = \frac{33{,}000 \times \text{H.P.}}{2 \pi r \text{N}}$$

The mean twisting moment

$$= p r = \frac{33{,}000 \times \text{H.P.}}{2 \pi \text{N}} \text{ ft.-lb.; or,}$$

$$p r = \frac{33{,}000 \times \text{H.P.} \times 12}{2 \pi \text{N}} \text{ in.-lb.}$$

$$= \frac{63{,}025 \times \text{H.P.}}{\text{N}} \text{ in.-lb.}$$

(To be continued.)

Peat as Fuel.

(*Continued from page* 25.)

UNDER the patents of Ashcroft and Betteley, operations were carried on at Lexington, Mass., for several years subsequently to 1864. Their process consisted in reducing the raw peat to a pulp, which was then conveyed into high tanks, where it was allowed to remain until, of its own weight and pressure, it became sufficiently dense to be formed into blocks, when small gates were opened at the bottom of the tanks and the superincumbent mass forced the peat out in a continuous sheet of uniform size. This was cut into blocks, which were laid away to dry. Experiments were also made with the view of drying peat by absorption, the plan being to cover the spreading ground with a layer or pavement of porous brick, on which the soft pulp was laid as it came from the machine. No great measure of success seems to have been achieved by either of these methods.

By a machine set up at Pekin, N.Y., in 1865, the invention of M. S. Roberts, the peat was ground to a pulp with water to the consistency of mortar, and then, by means of a long conveyor attached to the machine, spread on the ground and cut into blocks, which were left to solidify and dry in the open air.

In the process patented by T. H. Leavitt, of Boston, Mass., the apparatus consists principally of a strong box, 3ft. square and 6ft. high, supported upon a stout framework about 4ft. above the floor of a suitable building, which should be near the bog, and is best constructed on a side hill, so that easy access can be had to the lower storey on one side from the foot of the hill and to the second storey on the other side. The top of the tank should be open and even with the floor of the second storey, so that the raw peat can be dumped directly into it. Within the tank, and firmly fixed to its sides, are numerous projections of a variety of forms, adapted to the treatment of the material in its several stages as it passes through the mill, which is divided into three apartments. Through the centre of the tank revolves an upright, to which are affixed knives and arms, varying in form and structure to correspond to the stationary projections in each apartment. Below the tank is a receiver or hopper, and under this is a moulding or forming machine, 2ft. wide and 12ft. long, of simple construction, which receives the condensed material from the hopper and delivers it in blocks of any desired form and size, to be afterwards laid out upon the ground or on frames to dry. The whole is adapted to be driven by a small steam engine, and requires about 6H.P. and 10H.P. respectively for the two sizes of machines constructed, of the capacity of 50 and 100 tons each of crude peat per day of 10 hours. It is claimed for this treatment that it entirely destroys the original organisation of the peat and expels the air from its cells, thus allowing the water to evaporate so freely that at the end of eight or 10 days the peat is in a condition to be housed or transported to market. Figures are given by the inventor to show that in 1867, with ordinary labour at 1·75dol. per day, 25 tons of merchantable fuel could be prepared per day at an outlay for wages of 37·75dols., the cost of the apparatus itself being 4,500dols. The product was said to weigh from 65lb. to 80lb. per cubic foot, which is equal to a specific gravity of from 1·04 to 1·28.

Another machine is that of Thomas George Walker, which both grinds and artificially dries the material. The wet peat, after being puddled in a pug-mill vat, and heated by waste steam, is forced through the bottom into a box, whence it is blown by a steam jet through 400ft. of 6in. cast-iron pipe, coiled up in the furnace under the boiler, by which means it is thoroughly dried. It then passes through a larger pipe into a receiver, at the bottom of which it falls into a mould, where it is pressed into form by a plunger. The residual steam and gases pass from the top of this receiver in a tank through another pipe whose end is under water, in which any dust carried off by the steam is deposited; and the waste steam and gases thus purified pass thence back to the pug-mill jacket, where they are used to heat the new material. A second tank, under the pug mill, receives the water from the waste steam condensed in the jacket, and all combustible gases rising to the top are conveyed through a pipe to the furnace and utilised as fuel. The successive heating of the peat in the pug-mill vat and in the long passage through the 6in. pipe so prepares it that it is easily moulded into a compact form as it leaves the receiver.

The utilisation of the great peat deposits of Canada is no new project, and at various times during the last 30 years there have been brought to public notice processes which were claimed to have brought the production of a first-class peat fuel at a sufficiently low cost well within the domain of fact.

The Hodges system of peat manufacture, described by Sterry Hunt in the report of the Geological Survey of Canada for 1866, was deemed by that eminent scientist to be a very promising one, and likely to lead to the development and utilisation of the supply of peat in Canada. It consisted in a manufactory which should float about in the bog, cutting its own channel, excavating and pulping the peat, and finally spreading it out to dry—the whole without manual labour. The peat, after all sticks and roots were removed, was passed through machinery, which destroyed its fibre and reduced it to a homogeneous mass of soft pulp like well-tempered mortar. This was then spouted out to the surface of the bog, previously levelled and prepared for its reception, and spread in the form of a thin sheet 9in. in thickness and 90ft. in width. After lying a couple of days it began to consolidate, and was then divided by transverse cuts at intervals of 6in. In a few days more it was divided longitudinally, and in about a fortnight the shrinking of the peat caused the cuts to open, and gave the whole bed the appearance of an immense floor covered with bricks 18in. long by 6in. wide. As soon as these were sufficiently hard for handling they were taken up and stacked for drying. The manufacture of peat after this process was carried on by Mr. Hodges at Bulstrode, on the Three Rivers and Arthabaska Railway. Fifty tons of the air-dried peat fuel could be produced in a day of ten hours, costing, when dried and put into barges on the canal, according to Dr. Hunt, 92c. per ton. As thus prepared it contained about 25 per cent. of water, the greater part of which was lost by further drying.

The process invented and patented by Mr. David Aikman, of Montreal, is thus described by Mr. Aikman himself, in the specification forming part of letters patent granted him by the United States Patent Office on October 22, 1888:—"In manufacturing my improved fuel I prefer to take the peat in a semi-liquid or pulpy state, and after removing the sticks by any of the well-known devices, evaporate and remove the surplus water by stirring the pulp in a steam-heated vessel or chamber, and then complete the drying process by passing the peat through heated rollers, or between rollers and heated plates. This liberates the lighter volatile vapours and leaves the peat in small flakes or particles; but while undergoing the above operation the carbon cells are only partly broken, and, in order to finish what may be called the "fracture" of the cells and saturate the free carbon again with the highly inflammable tarry and resinous substances, and bind the same permanently together in a solid compact mass having the qualities above specified, I direct the peat thus dried and prepared into moulds kept at a high temperature by the direct application of fire, or by using superheated steam, and there reduce the same to a charred or carbonised condition. While this carbonising is going on the peat is kept under heavy pressure in the moulds by plungers or like devices (also brought to a highly-heated condition) until the fibrous or vegetable matter and the volatile elements are thoroughly incorporated together, and the exterior of the block is coated with the resinous matter and glazed by the friction and heat, and thus rendered water and air proof.

A method of preparing condensed peat fuel which has recently been invented by Mr. A. A. Dickson, of Montreal, contains some new features, and seems likely to lead to important results. In Mr. Dickson's process the peat is cut direct from the bog or bed, and elevated by carriers consisting of buckets attached to an endless chain, and discharged into a hopper, from which it is fed automatically through a novel three-roller pressing mill having hollow cylinders of perforated metal or wooden slats covered with felt cloth about 1½in. in thickness, which extracts the greater proportion of the moisture and delivers the peat in a semi-dry and spongy state, its fibrous nature not being destroyed or the component parts ground or pulverised, as is the case under most other processes. The peat is then lifted into a revolving cylinder constructed of boiler plate, having upon its inside longitudinal shelves of plate and hung with the axle of the intake end about 6in. higher than the axle of the outlet end. This cylinder is kept at a temperature of about 420° to 450° F. by exhaust heat of the boiler furnace delivered through a pipe, and with each revolution the peat is tossed and carried forward through the hot chamber to the outlet. Thence it is taken by carriers and delivered to another revolving drier, which consists of a series of cylinders, one arranged within the other, each being the frustrum of a cone connected by openings at the ends, and as the larger diameter is at the farther end, the peat is carried forward from one cylinder to another by a steady progressive movement towards the outlet with every revolution. Hot air is supplied in the same way as to the first cylinder, and when the now practically dry peat is finally discharged through a shoot it is taken up by an endless chain carrier and conveyed to a compressing machine, where it is subjected to a pressure of about 10,000lb. to the square inch, formed into the shape desired, and is then ready for market.

(To be continued.)

Trade Notes.

Messrs. Vickers, Sons and Co. Limited recommend a dividend of 6½ per cent. on the ordinary shares.

Messrs. James M'Kenzie and Co., Phœnix Tube Works, Glasgow, are carrying out important extensions at their works.

The orders for the steel required for the construction of the two Inman Liners in the United States have been placed with the home producers.

The Keystone Bridge Works, at Pitts-burg, U.S.A., have obtained an order for 50,000 tons of material for the Chicago elevated railway.

The Staveley Coal and Iron Company have secured an order for 620 tons of cast-iron pipes from the Board of Guardians of Cookstown, Ireland.

Messrs. A. Hall and Co., electrical en-gineers, Liverpool, have been instructed to prepare a report, specification, and estimate, for the electric lighting of Runcorn.

Messrs. Crossley Brothers Limited, Openshaw, have been awarded the order for two gas engines required for the sewage works at Islesworth, Middlesex.

Messrs. P. and W. Maclellan and Co., Glasgow, are to supply the cast-iron and steel work required in connection with the new tramway stables and car sheds at Whitevale-street, Glasgow. The order is worth about £2100.

The directors of Muntz's Metal Company Limited have resolved to recommend the payment of a dividend for the past year at the rate of 5 per cent. upon the preference shares, and of 10 per cent. upon the ordinary shares.

Messrs. Robert Boyle and Sons, ventila-ting engineers, Glasgow and London, have been awarded a gold medal for their patent self-acting air pump ventilator and air inlets at the International Exhibition, Kimberley South Africa.

The directors of the Brush Electrical Engineering Company Limited have declared an interim dividend at the rate of 6 per cent. per annum on the preference shares, and at the rate of 5 per cent. on the ordinary shares, for the six months ended December 31.

The Consett Iron Company, near Gates-head, are rolling the plates required for the new vessel "Gigantic," now in course of construction for the White Star Line by Messrs. Harland and Wolff, Belfast. The Stockton Malleable Iron Company are supplying plates for the same vessel, as well as iron pipes.

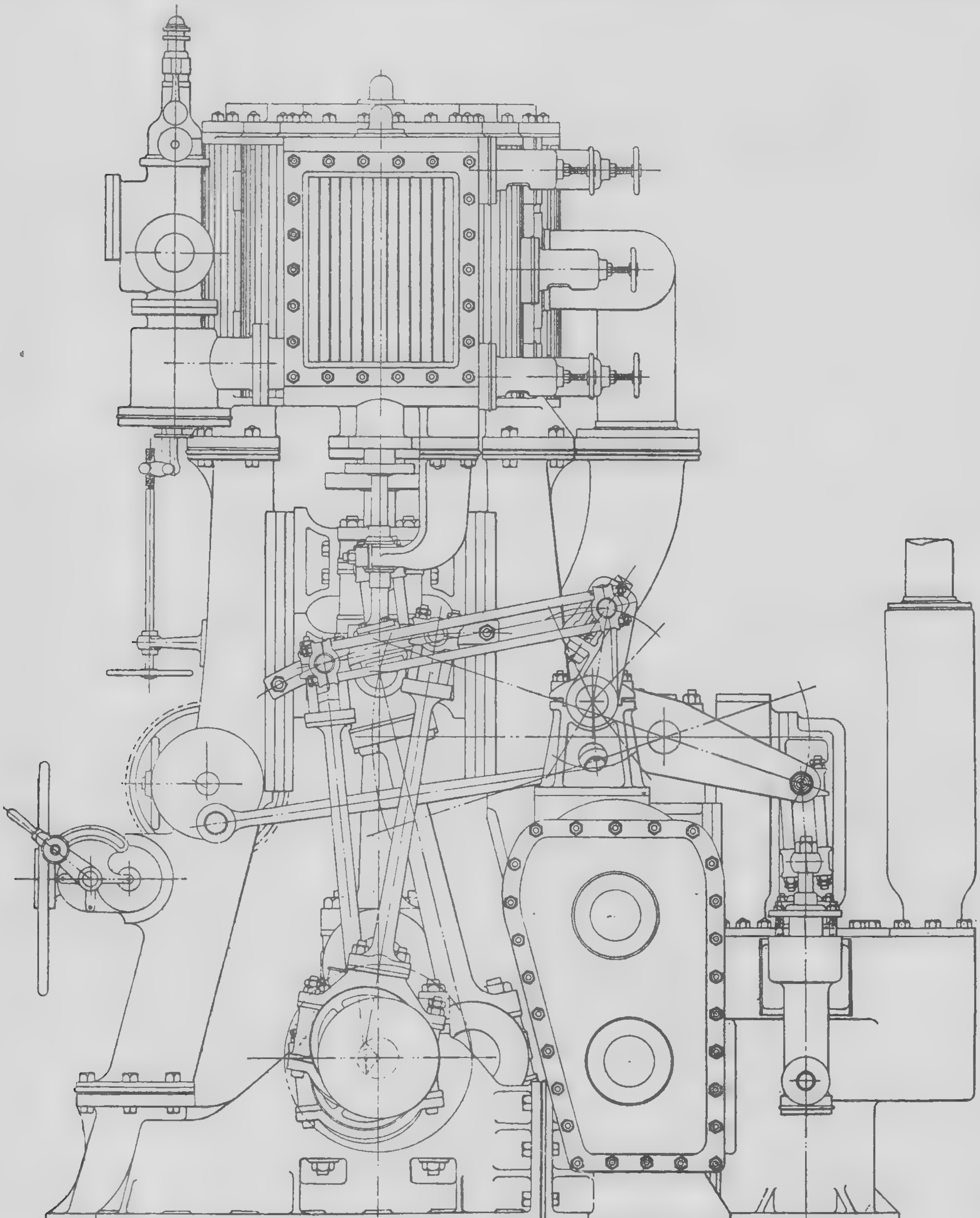
The contract for the machinery and appliances of a new retort house to be erected in connection with the Huddersfield Gasworks has been secured by Messrs. Barry, Henry and Co. Limited, Aberdeen. The contract, which will include engines, boilers, coal breakers, elevators, tanks, etc., will involve an expenditure of several thousand pounds.

Compound Engines of the Dredger "Blyth."

We give herewith a front elevation and a side elevation of the compound engines of the new hopper dredger "Blyth," recently built by Messrs. William Simons and Co., Renfrew, for the Blyth Harbour Commissioners. The dredger is 180ft. in length, 35ft. in breadth, and 14ft. in depth, and is specially designed and constructed for the dredging of rock previously blasted.

The buckets are of steel, and capable of lifting 400 tons of hard material per hour, and a greater quantity of free soil. The bucket ladder is fitted on the builders' patent traversing carriage, which projects the bucket in advance of the vessel, thus cutting its own flotation through shoals and banks. It is then brought back to its original position, and housed on deck, so as not to impede the vessel when steaming ahead. Steam steering gear, supplied by Messrs. Muir and Caldwell, is fitted amidships, having connections to flying bridge. Triple-geared steam mooring winches are provided at bow and stern for working the dredging chains.

The high-pressure cylinders of the engines are 19in. in diameter, and the low-pressure cylinders 38in. in diameter, each having a stroke of 24in. The engines, when connected to the propellers and hopper fully loaded, indicate about 900H.P. Steam is supplied by two large steel boilers placed forward of the engines. They are adapted for a working pressure of 90lb. per square inch, and tested to double that pressure. Each pair of engines is capable of driving the buckets.



Compound Engines of the Dredger "Blyth."—Side Elevation.

Notes on the Steam Injector.

Early History.—To Henri Jacques Giffard, an eminent French mathematician and engineer, belongs the honour of inventing, in the year 1858, the simplest boiler-feeding apparatus that has ever been devised, in which he applied in a novel and ingenious manner the latent power of a discharging steam jet.

The arrangements for feeding stationary boilers then usually employed were the ordinary steam or power pump, or the equilibrium apparatus—a closed iron tank feeding intermittently by gravity somewhat in the manner of a return trap. But there was an active demand, in locomotive service especially, for a compact and serviceable substitute for the unsatisfactory plunger pump.

Many years previously Giffard had directed his attention to the improvement of boiler feeders, and had patented an apparatus of entirely different character from the one that has made his name so well known; but the use of a jet of steam for forcing a continuous stream of water into a boiler appeared to him, on purely theoretical grounds, to be entirely feasible, and, if the practical difficulties could be overcome, would possess many advantages over the intermittent systems. The difficulty seemed to lie in fulfilling the peculiar conditions required for the condensation of the steam and the subsequent reduction of the velocity of the moving mass. Giffard carefully considered the various phases of the question and made a working drawing embodying his ideas. A model was made by MM. Flaud et Cie., of Paris, who met with very considerable difficulty in forming the tubes in the peculiar shapes required. But in the shape and proportions of the nozzles lay the element of success, and the first instrument constructed entirely fulfilled the expectation of the designer.

There have been few other inventions in which the underlying principles have been so thoroughly worked out by the original inventor. Giffard seems to have made a very complete survey of its possibilities prior to placing it before the public, and in his patent specification he describes a number of improvements that have since been made. In 1860 he published a small brochure entitled "A Theoretical and Practical Paper on the Self-acting Injector," in which he says: "Of all the necessary accessories of a steam engine, perhaps the most important is the one used for feeding water to the boiler. Upon its proper working depends not only the regular running of the engine, but the safety, the very existence of those who approach the boiler. . . . Nevertheless, by a kind of fatality, the apparatus employed up to the present time for feeding is, of all others, that which leaves most to be desired." After reviewing the disadvantages of the various methods in use, he continues: "It is important, therefore, to create a new method, free from the imperfection and inconvenience pointed out," and modestly adds, "Such is, it appears to me, the result obtained by the apparatus to which I have given the name of injector, because it produces a veritable continuous injection. Its mode of action, extraordinary in appearance, contrary to that which we are in the habit of seeing or supposing, is explained by the simplest laws of mechanics, and has been foreseen and calculated in advance." He describes his invention in detail, and explains very fully the best proportions for its various parts, and also the mechanical theory, substantially as advanced by him in 1850, eight years before the construction of his experimental injector.

And yet, in common with all new inventions and radical improvements, great difficulty was at first experienced in obtaining a fair trial of its merits, and in many cases the exaggerated claims of its friends interfered as much with its early adoption as the openly-expressed criticism of its enemies. The great advantages of the new method were appreciated, however, by the Academie des Sciences of France, who awarded Giffard the Grand Mechanical Prize for 1859. This was all the more complimentary as it was entirely unsolicited. Prominent engineers presented before the principal scientific societies analytical demonstrations of the theory of the injector, and allayed to a great extent the suspicion in the popular mind that the inventor was encroaching dangerously near the claim for perpetual motion. Combes, Bougere, Reech, Villiers, Zuber, and Pochet are among the most prominent scientists who made a special study of the subject, and the demonstration of Pochet is still frequently used in modern text-books.

It must not be supposed that Giffard was alone in his efforts to supply a continuous feed to the boiler. For exhausting and pumping purposes we have record that steam jets had been used as early as 1570 by Vitrio and Philebert de Lorme, and other inventors had endeavoured unsuccessfully to force the jet to enter the boiler; but, for reasons that will be given later, it is easy to understand why they failed, as they omitted to apply the scientific principles that made Giffard's first experiment a success.

In 1859, the injector was introduced in England by Sharpe, Stewart and Co., of Manchester, but did not at first become popular; possibly on account of the mystery that seemed to surround its working, and the general scepticism as to its practical wearing powers. Some of the contributions and queries published in the engineering papers of the day are very amusing, and a certain writer in one of the most prominent weeklies proves most conclusively to his own and probably to some of his readers' satisfaction that the new method of feeding boilers was an absolute impossibility. The injector was, however, adopted in many places and continued to give satisfaction. In the first trip of the "Great Eastern" injectors were used in place of pumps, but, for some reason not explained, they were subsequently removed. This may have been owing to the temperature of the feed-water being too high for efficient service, as this was the weak point of the first injectors constructed.

The English railroads opened a wide field for the injector. Upon most of the locomotives the earliest feeding pumps were worked by hand, but afterwards coupled to a special eccentric or to the crosshead. Stretton, in his recent work on "The Locomotive," says that it was a common occurrence for engines with a single pair of driving wheels to stand on well-greased rails with tender brakes fast locked and drivers revolving in order to fill the boiler full of water. But even though the old methods were very crude, engineers in England laughed at Giffard when he attempted to introduce his injector, and it was only after a year of persistent effort that he succeeded in obtaining a trial upon a locomotive, and the concession was granted to prove the folly of the inventor and obtain a respite from his numerous letters and appeals.

In 1860 William Sellers and Co. commenced the manufacture of the injector at their works in Philadelphia, and the first injector was applied to a locomotive in the United States on the Detroit and Milwaukee Railroad in October, 1860. The Pennsylvania Railroad and Philadelphia and Reading Railroad followed in the latter part of the same year. Of locomotive builders, Matthias Baldwin was the first to use the new instrument, applying in September, 1860, a No. 8 injector to an engine designed for the Clarksville and Louisville Railroad.

To Joseph R. Anderson and Co., Richmond, Va., a No. 4 injector, bearing

progressive No. 1, was shipped in October, 1860. As indicative of the wearing qualities of these early instruments, it may be stated that there was returned to Messrs. William Sellers and Co. in 1887 a No. 4 injector, progressive No. 7, after a nearly continuous service of 27 years, having in that time required but few repairs. It is very interesting to note that, owing to improvements recently introduced, American injectors are now extensively used in France, and have been adopted as a standard type by several of the Government railroads in the country of its inventor.

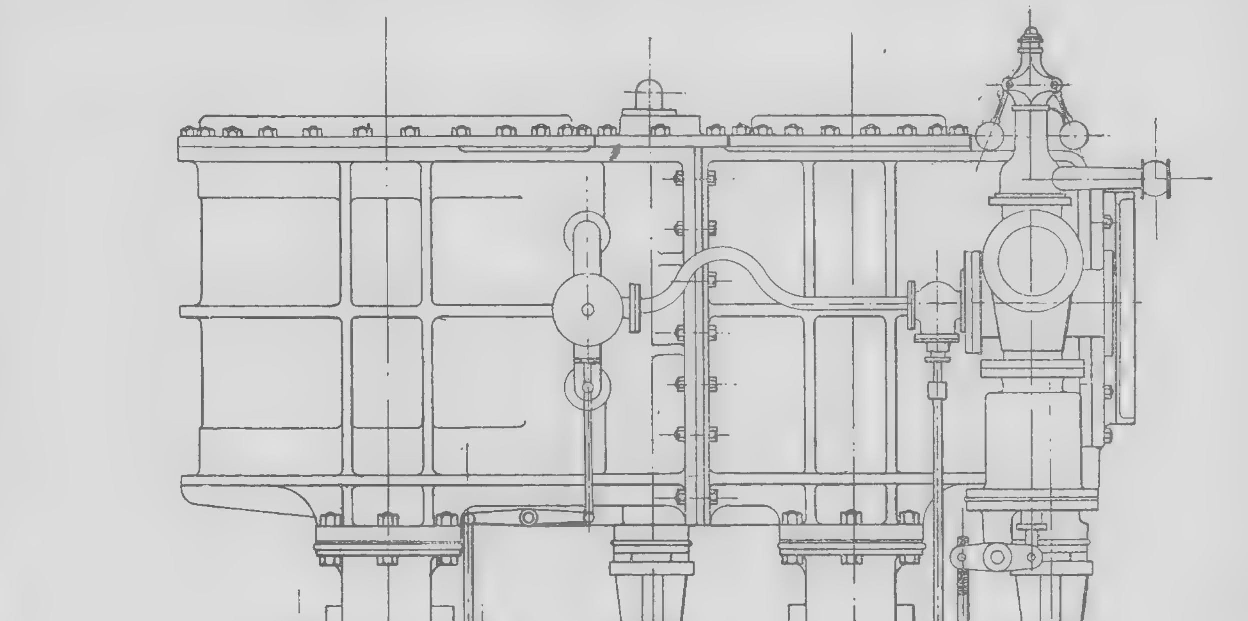
It need hardly be said that the injector is the most popular boiler feeder now in use. There have been more than 500,000 manufactured in this country for the various kinds of service, and there is scarcely a locomotive in the world that is not equipped with one or two injectors. Compact, reliable, and economical, it still deserves the high encomium bestowed upon it by M. Ch. Combes, inspector-general and director L'Ecole des Mines:—"It is without doubt better than all devices hitherto used for feeding boilers, and the best that can be employed, as it is most ingenious and simple."

(To be continued.)

The Training of Young Marine Engineers.

(Concluded from page 58.)

In Holland, under a law passed in March, 1891, marine engineers may pass an examination qualifying for the position of engineer in the mercantile marine, the certificates granted to those who pass the stipulated examination being A, B, and C classes. Certificate A is one which enables the holder to serve as second engineer on board of vessels exclusively engaged in carrying cargo, or as third engineer in any merchant vessel. Certificate B entitles the holder to act as chief engineer of vessels exclusively engaged in cargo carrying between European ports only, or to such Asiatic or African ports as are situated in the Mediterranean and Black Seas, or as second engineer in any merchant vessel. Certificate C allows the person possessing the same to act as chief engineer on any merchant ship. After describing in considerable detail the subjects, etc., in which candidates for these several certificates are examined, Mr. Sage continued:—These examinations for engineers having only just been instituted (March 1891), and not being compulsory, are, considering the latter condition, being pretty generally adopted by the better class of men, who very correctly suppose that the possession of these certificates give them a certain standing. Though these examinations are not compulsory, the more important lines of steamers generally carry certificated men, as some of the shippers will not send goods except in vessels so provided. C certificate allows a man to go as chief engineer of any vessel in any trade. B certificate enables the holder to be second engineer of any vessel in any trade, or chief of a non-passenger vessel not going beyond the Black Sea and Mediterranean. Vessels carrying the C certificate as chief, generally carry a second with a B and a third with an A certificate, and vessels with B chiefs have A seconds. Examination of engineers was made compulsory in Germany by a decree of June, 1879, and the classes are first, second, and third. A man possessing a third engineer's certificate may take charge of tugboats and such sea-going vessels as do not go farther from the coast than 50 German sea miles. Second engineer's certificates entitle the holder thereof to take charge of the engines of steamers in the European trade and the European ports in the Mediterranean, Black, and Azof Seas. With a first engineer's certificate a man is allowed to take charge of the engines of any merchant vessel in any trade. Candidates for certificates as third-class engineers are required to produce vouchers of having served (after attaining the age of 15) an apprenticeship of four years, either entirely as one of the hands in an engine-room, or part of that time as such, and the remainder of the time in an engineering shop. Of the apprenticeship in the engine-room, at least twelve months must be served in a vessel engaged in trade. Candidates for certificates as second-class engineers must have served five years in engine-room and engine works, of which three years must have been in works and two years of actual sea experience. Candidates for certificates as chief or first-class engineers must have served at least two years as second engineer in vessels engaged in actual sea work. The law as to the manning of German vessels so far as engineers are concerned is as follows:—Tugs and vessels which do not go more than 50 German sea miles from the coast must have at least one third-class engineer on board. Sea-going vessels in European, Black Sea, etc., trades must have a second-class engineer in charge, and at least one third-class engineer. For vessels going beyond the above limits there must be one first-class engineer in charge, and at least one second-class man. The examinations are conducted by a board consisting of a president, an officer engineer of the imperial navy, or an engineer of the merchant marine, provided he has been educated at a technical college; or an engineer engaged in the construction and working of marine engines who has had at least one year's sea service, and a teacher of navigation of one of the public schools, or a teacher of mathematics. The French laws respecting engineers' certificates appear to vary in the different ports, as at Havre only is it required that a man should have seen shop service before he can pass. Most of the engineers in the French mercantile marine have been, and still are, in the navy, as everyone is required to serve on active service three years, and up to a certain age in the reserve, being called out every two years for two or three weeks' drill, and, unless under exceptional circumstances, the rank they hold in the navy fixes the grade they are entitled to serve at in the merchant ships. Engineers must serve in the lower grades two years before being eligible to pass the examination for the next higher. In Spain an order was issued by the Government that all vessels carrying passengers should have certified engineers, and those who had been six years as chief were granted first-class, and those who had been six years in any capacity in the engine-room were allotted second-class certificates, and in this way many men who were not engineers at all, but who had managed to creep into office, were given the hall mark, as was the case in our own country at the commencement of the certificate era, when certificates of service were granted to men who by some incident had been placed in charge of engines for a short time. In the Italian service a man can pass his first-class examination before he goes to sea at all. Below the second engineer, certificates are not required in Italian vessels, but after a man has served two years at sea he has to pass an examination of a comparatively easy nature, and then gets his first-class certificate. We will take it that our student of marine engineering has returned from his first voyage, and is the proud possessor of a discharge as assistant engineer. He must, according to the Board of Trade regulations, go to sea as an assistant, and one who has the charge of a watch too, for one year, before he can submit himself for examination as a second-class engineer. In many large vessels the watches are kept by the second, third, and fourth, and as nearly all of these are certificated men, it may be a long time before our student, if he be in one of these steamers, can get the qualifying time in, and therefore I consider it would be better if the present regulations of the Board of Trade were altered and amended. Firstly, to create a third-class certificate, the qualification for which should be two years' service as an assistant or apprentice engineer, in any trade, in any steam sea-going vessel of above 100 tons net register, and the passing of an examination of a slightly lower grade than that prescribed at present for second-class engineers; candidates to prove satisfactorily to the Board of Trade that they have worked in some shop for the making or repairs of marine or other steam engines for not less than three years; one year's actual sea service, with the third-class certificate, to be served before candidate can apply to be examined for admission to the next higher grade. Two years' service with a second-class certificate in any seagoing steamship (providing always that the candidate has had charge of a watch all the time) to be necessary before the examination for first class can be passed. It will be admitted, I think, upon all hands that while the regulations I have here advocated may impose more stringent conditions, and extend the time in which a man may obtain his certificates, as compared with the regulations at present in force, the result would be that we should have more experienced engineers to man our ships, and I think more credit would then be given to the holder of a first-class certificate than is now the case. Under the existing regulations it is within the bounds of possibility for a man to hold a first-class certificate of competency by the time he is a little over 22 years of age. Before leaving the subject of the Board of Trade regulations governing the examination of engineers, the rules of the same body, and their requirements as to the compulsory use of certificates on board British steam vessels, I will just mention a very serious flaw in those regulations. The law says: "Every foreign-going steamship or home-trade passenger steamship," or words to that effect, "shall carry certificated engineers." Now, the above-quoted paragraph leaves out of its jurisdiction a very large number of vessels that should, in my opinion, be included in it—viz., vessels that are neither engaged in the foreign trade



Compound Engines of the Dredger "Flyth."—Front Elevation.

nor the home passenger trade. There are a large number of vessels of all kinds, some of them with all the latest improvements in marine engineering, engaged upon our coasts, and within the limits of the home trade—viz., the Elbe and the Brest—which may go to sea, and carry paying passengers too, without a certificated man aboard. It is, in my opinion, not fair or just to those engineers who have passed the examinations prescribed by the Board of Trade, at great trouble and expense, that uncertificated men should be allowed to take charge of marine engines at sea. I am of opinion that all men who are called upon to take charge of engines and boilers, either at sea or on land, should be certified in some way as being qualified for their posts; and it is only a question of time, I hope, before this will be made the subject of legislation. Having brought our student of marine engineering safely through his maiden voyage, we must now consider the training which would be most beneficial to him in his year of sea service, which is the period fixed by the Board of Trade before he can go up to be examined as to his fitness to act as second engineer of vessels having engines of more than 100N.H.P., or chief engineer of vessels under that horse-power. It is highly desirable that the student, during his first year of sea service, should be under the charge of men who, besides being capable of teaching him the points of the profession, are also willing to act to that end; and no less is it desirable, in this second apprenticeship, as I may call it, that the pupil should be anxious and willing to be so taught by those of larger experience in such matters than himself. I am very strongly of the opinion that under the existing regulations it is not advisable for the student to present himself for examination so soon as he has got the required time upon his discharges; but would advise that he have at least 50 per cent. more, as it were, "up his sleeve," to veer and haul upon, and it is not desirable (at least, in my opinion it is not) for the student to serve the whole of his time in one ship, as that prevents him from becoming acquainted with the engines and boilers of more than one make only, and though the principle of all marine engines is the same, the details very often vary considerably, and it is well to be acquainted with these variations. We will further assume that our student has now "put in his time," "passed the Board," and got his "ticket" (blue print) which gives him the proud privilege of acting as second engineer in any vessel in the British mercantile marine if he can get the berth as such. Our student has now become an engineer—a second-class one, it is true, but he is now practically out of his time, the apprenticeship to the sea being over. But though no longer a student, he must not cease to study; on the contrary, he must study more than ever, and lose no chance of improving his knowledge of the massive machinery which propels the vessel under his feet. I apologise for introducing at such length the regulations regarding the examinations of engineers in Holland and Germany, and regret very much that the former nation has not made it compulsory; but that no doubt will come ere long, and it is a consummation devoutly to be wished. You will see that the Dutch and Germans have a system of apprentice sea-going engineers, and I must say that I approve of same, and consider that all young men on first going to sea should be so styled for a certain time, and should not be allowed to take charge of a watch without they can produce certificates from chief engineers, with whom they have served, of their fitness to do so.

Metal Trade Memoranda.

The output of ore from the Marbella Iron Ore Company's mines during the month of January amounted to 3765 tons.

The output of gold for the month of January at the Witwatersrand Goldfields, Transvaal, was 108,374oz. The output for January, 1892, was 84,600oz.

The Arizona Copper Company's mines during the month of January produced 321 tons of black copper and 10 tons of matte, which is equivalent to about 328 tons of copper.

The Parkgate Iron and Steel Company have restarted one of their five blast furnaces. These have been standing several weeks owing to depression and the strike at the Frodingham ironstone mines.

The production of Bessemer steel ingots in the United States during 1892 amounted to 4,160,972 gross tons an increase of 913,555 tons as compared with the previous year. The production of Bessemer steel rails reached 1,458,745 tons, an increase of 219,350 tons over the previous year.

Official Gazette.

Partnerships Dissolved.

E. Ford and W. H. Harrison, under the style of Ford, Harrison and Co., Heath-town, near Wolverhampton, nut and bolt manufacturers.

C. F. Dixon and C. E. Hawley, under the style of the Cleveland Bridge and Engineering Company, Cleveland Bridge and Engineering Works, Bank Top, Darlington, engineers and contractors and manufacturers of iron and other bridges.

J. Parkes, A. H. Lane, T. Parkes, and J. Hingley, under the firm of the Cakemore Bolt, Nut, and Manufacturing Company, Cakemore, Worcester, bolt and nut manufacturers; so far as regards J. Hingley.

T. Allen, E. H. Brown, and H. H. Brown, under the style of Houghton Brown Brothers, Kingsbury Ironworks, Ball's Pond, N., and Barberton, South African Republic, mechanical engineers.

New Companies.

Australian Wire Netting Company Limited.—This company was registered on the 6th inst., with a capital of £20,000, in £1 shares, to carry on in London, in the colonies of New South Wales and Victoria, or at such other places as may be decided upon, the businesses of iron wire manufacturers, engineers, contractors, and other similar businesses.

The Metal Market.

PRICES CURRENT.

LONDON, Feb. 13.

Copper opened quietly, and initial business was done at a decline of 1s. 3d., cash making £45 6s. 3d. Buyers operated slowly, and later on, owing to rather free offerings, three months receded to £45 15s. Near positions were steady at £45 5s., and £45 6s. 3d. was paid for 10 and 11 days prompt, with good buying thereat; but in the afternoon, on renewed selling, three months was set back to £45 13s. 9d., the market closing steadily at a loss of 2s. 6d. to 3s. 9d. Sales, 750 tons. Settlement price, £45 5s. English tough, £48 5s.; best selected, £49 10s.; strong sheets, £57 10s. to £58.

Tin has ruled quiet, but, with little pressure to sell, prices have only gone back 2s 6d Transactions covered cash at £91 12s. 6d., paid at both sessions, and during early trading three months made £92 5s. The close is firm at the quotations. Sales, 70 tons. Settlement price, £91 12s. 6d. English ingots, £95.

Pig Iron trading has shown no change in its character, negotiations being directed to future deliveries. Three months was bid for at 41s. 6d. to 41s. 9d., and offered at 42s. 3d., but without any business resulting, and the market closed steadily at former rates, hematite being exceptionally 1½d lower. Settlement prices:—Scotch, 47s.; Middlesbrough, 35s.; hematite, 45s 7d.

Tinplates in limited demand. I.C. cokes, f.o.b. London, 12s. 7½d.; Liverpool, 12s. 1½d.; Swansea, 11s. 7½d.

Lead has ruled quiet, with soft Spanish offering for £9 12s. 6d.; English, £9 15s.

Spelter is nominally £17 ?s. 6d. sellers; buyers offering £17 for virgin brands for February shipment.

Zinc Sheets.—Silesian are quiet at £20 2s. 6d. to £20 5s., ex ship., sellers. Belgian are dull: V.M. brand, ex ship., £20 17s. 6d.; f.o.b. Antwerp, £20 15s.

Official Closing Quotations.

	To-day. £ s. d.	£ s. d.
Copper—		
G. M. B.—Cash	45 5 0	—45 12 6
" Three months	45 13 9	—46 1 3
English tough	— — —	
Best selected	— — —	
Strong sheets	— — —	
Tin—		
Fine foreign—Cash	91 12 6	—92 2 6
" " Three months	92 5 0	—92 15 0
Australian—Cash	92 2 6	—92 12 6
Pig Iron—		s. d.
Scotch warrants—Cash		47 0
" One month		—
Middlesbrough—Cash		35 0
" One month		—
Hematite—Cash		45 7½
" One month		—

GLASGOW, Feb. 13.—As regards official dealing this was a blank day on the pig iron market. The corner in Scotch monopolises attention, and only those interested dare operate. Though no ring transactions were recorded, some few lots of Scotch changed hands outside at 48s. cash, and it was reported that 6d. more was paid, a rise of 1s. on Friday's close. Sellers at finish asked 48s. 6d. The shipments of Scotch last week were 4414 tons, a decrease of 2713 tons on the corresponding week of last year, and making a decrease for the year of 3715 tons.

Quotations.

	Highest. s. d.	Lowest s. d.
Scotch warrants—Cash	48 6	47 0
" One month	—	—
Middlesbrough—Cash	35 0	35 0
" One month	—	—
Hematite—Cash	45 7½	45 7½
" One month	—	—

An omnibus is running in Glasgow fitted with pneumatic tyres, which are protected from injury by sharp stones or glass by canvas and wire-wove netting. It has proved a success. There is no jolting or jarring, and the noise is reduced to a minimum.

The death took place, on the 8th inst., of Mr. George Mathews Whipple, superintendent of the Kew Observatory. He entered the Observatory in 1858, and in 1862 became magnetic assistant. In 1876 he was appointed superintendent. Mr. Whipple designed the apparatus used for testing the dark shades of sextants and other optical instruments, and also introduced several improvements in the Kew pattern magnetic instruments. He was 50 years of age.

Letters to the Editor.

**** We do not hold ourselves responsible for opinions expressed by correspondents.*

**** The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

**** Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

CRANKSHAFT CALCULATIONS.

To the Editor of The Mechanical World.

Sir,—The following calculations for finding the size of a marine crankshaft, by Seaton, Rankine, and Unwin's methods have been taken from examples as found in actual practice, and are submitted for comment and criticism. The first case selected is a compound, surface condensing, vertical, direct-acting engine, with cylinders 25½in. and 46½in. diameter, by 2ft. stroke; length of connecting rod, 4ft. 7¾in.; boiler pressure, 60lb. The maximum effective initial pressure on high-pressure piston = 60 − 3lb. back pressure = 57lb. per sq. in. ∴ Total load = 510·7 × 57 = 29,110lb. Maximum absolute initial pressure on low-pressure piston = 18lb. per sq. in. = 1698·2 × 18 = 30,567lb. total load. By theory, the four journals would be of different diameters; but in actual practice we calculate for the largest diameter, which in this case is the after-journal of the aftward crank. As this journal has to resist the action of its own piston, and also to transmit the twisting strain of the high-pressure engine, we must first calculate the twisting moment of the high-pressure engine. The greatest thrust along the connecting rod when at half-stroke, due to 29,110lb. load on piston, is found to = 29,810lb. ∴ Maximum twisting moment = 29,810 × 12in. (throw of crank) = 357,720in.-lb.

(Note.—The shaft is 7in. diameter throughout, and made of steel. The Board of Trade rule works out in this case 7in. diameter for an iron shaft.)

Now dealing with the low-pressure engine. The greatest thrust along the connecting rod when at half-stroke, due to 30,567lb. load on piston, is found to = 31,302lb. ∴ Maximum twisting moment = 31,302 × 12in. (throw of crank) = 375,624in.-lb. The bending moment

$$= \frac{30{,}576 + 22\tfrac{1}{4}\text{in.}}{4} = 170{,}080\text{in.-lb.}$$

22¼in. = distance between bedplate facings for shaft brasses.

Now let T_2 = the maximum twisting moment on the low-pressure engine; M_2 = the maximum bending moment on the low-pressure engine; T_1 = the maximum twisting moment on the high-pressure engine. By Seaton's rule:—On the after-journal of the aftward crank the twisting moment is $T_2 + T_1$, and the bending moment $\frac{M_2}{2}$; so that equivalent twisting moment on after-journal of aftward crank

$$= \frac{M_2}{2} + \sqrt{\left(\frac{M_2}{2}\right)^2 + (T_2 + T_1)^2}$$

$$\frac{M_2}{2} = 85{,}040\text{in.-lb.}$$

$$85{,}040 + \sqrt{85{,}040^2 + (375{,}624 + 357{,}720)^2}$$
$$= 823{,}298\text{in-lb.}$$

By Rankine's and Unwin's rule:—

$$M + \sqrt{M^2 + (T_2 + T_1)^2}$$

$$= 170{,}080 + \sqrt{170{,}080^2 + (375{,}624 + 357{,}720)^2}$$
$$= 922{,}888\text{in.-lb.}$$

$$d = \sqrt[3]{\frac{823{,}298}{12{,}000}} \times 5{\cdot}1$$

$$= \sqrt[3]{350} = 7{\cdot}04\text{in. (Seaton).}$$

$$d = \sqrt[3]{\frac{922{,}888}{12{,}000}} \times 5{\cdot}1$$

$$= \sqrt[3]{392} = 7{\cdot}3\text{in. (Rankine and Unwin).}$$

(Note.—Having taken the greatest loads that are ever likely to come on the pistons, we may admit the high stress of 12,000lb. per square inch on the shaft for steel.) Thus proving the formulæ to meet the requirements of practice.

For the second case, I will take an example found in actual practice of a small iron crank shaft 4½in. diameter, used for a simple engine (condensing), throw of crank 4½in., length of connecting rod = 30in., and the maximum absolute load on piston = 13,252lb.

The Board of Trade rule for marine shafts in this case works out 3½in. diameter. But this only allows for the bearings being approximately close up to the crank arms, and the engine effort given off midway between the bearings; but in the present case the arrangement is as shown below.

Now we will consider the shaft as a beam well supported at both ends, first finding the bending moment at P due to P.

$$\text{B M at P} = \frac{P \times l^1 \times l^2}{L} = 64{,}340\text{in.-lb.}$$

Maximum twisting moment = R × throw of crank; R = greatest thrust along connecting rod, found to be 13,404lb. ∴ The twisting moment = 13,404 × 4½in. = 60,318in.-lb. Now let T = the maximum twisting moment; M = the maximum bending moment; T_1 = the maximum equivalent twisting moment. Then by formula for combining the bending and twisting moments we obtain:—

$$T_1 = \frac{M}{2} + \sqrt{\frac{M^2}{2} + T^2} \text{ (Seaton).}$$

$$32{,}170 + \sqrt{32{,}170^2 + 60{,}318^2} = 100{,}530\text{in.-lb.}$$

$$d = \sqrt{\frac{100{,}530}{9000}} \times 5{\cdot}1 = 3{\cdot}8\text{in. diameter.}$$

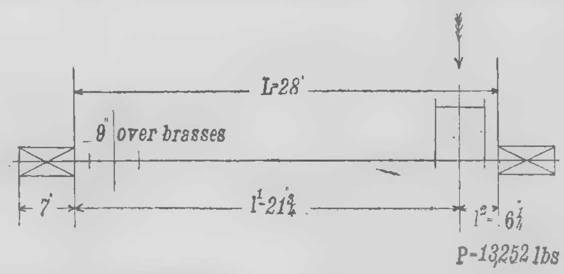
By Rankine and Unwin:—

$$T_1 = M + \sqrt{M^2 + T^2}$$

$$64{,}340 + \sqrt{64{,}340^2 + 60{,}318^2} = 152{,}590\text{in.-lb.}$$

$$d = \sqrt[(3)]{\frac{152{,}590}{9000}} \times 5{\cdot}1 = 4{\cdot}4\text{in.}$$

4½in. diameter is evidently ample for this engine, as the greatest load has been taken that is ever likely to come on the piston.



W. A. P.

Dover, Feb. 8.

Miscellaneous Items.

A rich naphtha well has been discovered in the district of Ter, Russia, at a depth of 72ft.

Asbestos mines in Wyoming are being opened up; but the product is not claimed to be equal in quality to the supplies from Canada.

The 37th anniversary dinner of the Manchester Association of Engineers was held on the 11th inst., at the Grand Hotel. Mr. T. Daniels, the president, occupied the chair.

The adoption of gas for illuminating railway carriages is rapidly extending in the United States. Two new Pintsch gas plants have been erected at Kansas City and Toledo.

It has been decided to extend the operations in connection with the coal boring at the Channel Tunnel Works, near Dover. During the last few weeks the result of the boring has confirmed the opinions of the promoters of the existence of workable coal seams, similar to those on the other side of the Channel.

The sinking operations for coal at Barmoor Clough, near Dove Holes, Derbyshire, have proved completely successful, and it is now believed that a stimulus will be given to the revival of the lead mining industry in the district. The coal is stated to be of good quality and the vein of some thickness.

One of the sights of China is the antique bridge of Suon-tchenfow, 2500ft. long and 20ft. wide. It has on each side 52 piers, upon which huge stones are laid, some of them 20ft. long. Many thousand tons of stone must have been used in the erection of this wonderful bridge, which is regarded by engineers who have seen it as indicating constructive talent as wonderful as that which raised the Egyptian Pyramids.

The Norwegian Viking ship, to be sent to America for exhibition at the Chicago World's Fair, was launched at Sandefjord on the 4th inst., in the presence of an immense crowd of spectators, and amid great enthusiasm. The ceremony was favoured by fine weather, and among those present was Admiral Koren, Commander-in-Chief of the Norwegian Navy.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

POOLE'S GRINDING MACHINE FOR LATHES.—Required, the address of makers of this machine,

DISINFECTANT.—Will any reader kindly tell me how to make a cheap and effective disinfectant powder?—BOILERS.

IRON MANUFACTURE.—Required, particulars of the Husgafel process of making iron blooms direct from the ore.—F. C.

FILTRATION.—Will any reader state the best method of filtering 150 gallons of canal water per day for steam-boiler purposes?—T. H. MITCHELL.

TWIST DRILL CUTTERS.—Can any reader give me a method of getting the correct thickness and shape of cutter for any diameter of twist drill, straight lip? A drawing will greatly oblige.—J. M. F.

RUST JOINTS.—How can I stop leakage in a vertical joint (rust joint) in my hot-water pipes (low-pressure system) without cutting out the packing? Would any fluid cement percolate into the crevices and harden there? —B.

LOCOMOTIVE. — Will any reader of THE MECHANICAL WORLD kindly give me the best way to trammel a locomotive which has too much play in the axle boxes and more on one side than the other? There are no centre marks on the crankpins.—DUBBS.

ENGINEERS' WAGES.—Would any reader kindly give me some information as to the wages at Cape Colony and Mexico for mechanical engineers?—REGULAR READER OF "THE MECHANICAL WORLD."

HEATING FURNACE.— Will any reader kindly give particulars, with rough sketch, of furnace suitable for heating and fagotting iron up to 3in. diameter and about 2ft. long for 2cwt. steam hammer?—HAMMER.

MAKERS OF BUILDERS' IRONWORK.—Can any reader furnish me with addresses of firms who are makers of machinery for making builders' ironwork, such as bands and hooks, cavity irons, etc?—SMITH.

ELECTRICAL RESISTANCE.—Can any reader give me any information relative to the resistance offered to the passage of electricity by carbon rods and platinium wire? Is there a small work published on the subject? If I had formula, I could work out myself.—CARBON.

BOILING COPPERS.—What is the grate area required to boil five 100-gallon coppers and one 50-gallon copper? Said coppers are steam jacketed; inside of copper, outside of wrought iron; boiler pressure 80lb., reduced to 7lb. before reaching coppers. Will be glad of rule for calculating above.—G. HAYWOOD.

WINDING ENGINE.—What weight would a pair of 36in. cylinder engines by 4½ft. stroke raise from a pit with a spiral drum, commencing at 14ft. and finishing at 18ft. diameter, one side to wind from a depth of 350yds. and the other side from 400yds; ropes to be 1¼in. diameter, boiler pressure 30lb. per square inch, cut-off at ⅝ stroke? What weight would the above engines raise from a depth of 283yds., with a flat rope drum, commencing at 12ft. diameter; sizes of ropes 5½in. by ⅝in. (steel)? What would be the rise in inches per yard of a slant whose angle is 26 degrees?—MINER.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

W. WARREN.—Yes; it is called the Lampe Belge.

ROLLING STONE.—We make the screw 5¾ threads per inch.

J. M. C.—There is an article in our issue for February 4, 1888, which will suit you.

WINCHMAN.—It would be impossible to obtain the information asked for.

F. C.—(1.) Apply to Messrs. E. and F. W. Spon, 125, Strand, London. (2.) No; we have no prospectus.

OLD SUBSCRIBER.—They are usually polished, but this is a difficult operation for the tyro to attempt.

JOSEPH DALE.—The quantity will depend upon the character of the water. Your best plan is to write the Aston Chemical Company, Birmingham.

ELECTRIC.—We think your only plan is to consult a foreign trades directory, which you will probably find in the Free Public Library in Liverpool.

CIVIL ENGINEER.—If you require to know the conditions of membership of the Inst. C.E., you must apply to the Secretary, 29, St. George-street, Westminster, London, S.W.

F. HANLINE.—We think the Phœnix Metal, Die, and Engineering Company Limited, 40, Princes-street, Stamford-street, London, S.E., will be able to assist you. Would not an electrotype impression answer?

METALS.—Forge a piece of copper to the size required, and screw into it a handle formed of iron rod. Clean the end by filing, and tin by applying killed spirits of salts and solder. "Killed spirits" is made by immersing small pieces of zinc in hydrochloric acid.

BODY BELT.—No; you are mistaken in supposing that we ever gave directions for the manufacture of such bogus appliances.

SUBSCRIBER.—We are glad to find the articles are so much appreciated, but are afraid we cannot publish them more rapidly than at present. We have other readers' requirements to consider.

MILLING MACHINE.—(1.) Hasluck's "Milling Machines and Processes," 12s. 6d., which may be had from our office. (2.) Mr. Hart, of Blackburn, will send you particulars as to splicing cotton ropes upon application. There is no book on the subject.

YOUNG FOREMAN.—If you place equal wheels on the centre and screw, you will obtain a feed of 1⁄16in. per revolution of the boring bar. If you wish for a slower feed, increase the diameter of the wheel on the screw and decrease that fixed on the centre in proportion to your requirements. If you do not understand this clearly write again.

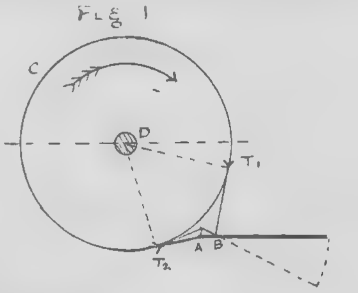
EDWARD F. KING.—Try the following process for bronzing gun barrels:—Take 1oz. of copper sulphate, 1oz. of spirits of nitre, and 20oz. of water. Dissolve the copper sulphate in water, and then add the other ingredients. The mixture is then put on and allowed to remain 24 hours, when it is brushed off with a stiff brush. If the colour is not dark enough, the operation may be repeated.

"GRASS" PACKING.—Can any reader supply me with the address of manufacturers of this packing? I have seen it used for the piston and valve rods of L. and N.-W. Railway engines.—LOCO.——A.—If "Loco" will communicate with the writer, he will obtain all information, etc.—G. E. GREAVES, 47, Leadenhall-street, London.

TRACTION ENGINE.—Would any maker or user of modern traction engines kindly give the weight of traction engine capable of drawing 20 tons net weight; also average consumption of coal and speed in miles per hour with and without load, and at what degree of ascent and descent is it capable of taking the load with safety, taking in all cases the average road?—J. W.——A.—The modern traction engine generally in use on our roads is 8N.H.P., weight about 15 tons, and is capable of drawing its own weight (net) comfortably "uphill and down," though it often draws considerably more than 20 tons (net) on favourable roads. Speed is limited by statute to two miles per hour in towns and villages, and four miles per hour in open country. A good engine will mount any hill where a horse and cart can get, provided the road has a solid bottom. As to safety, an engine is always safe to come down where it can get up (properly manned, of course). As to coal consumption, this is ruled by conditions of engine and of road; the ability of the driver, too, has something to do with this. The writer has often hauled 15 tons 20 miles, return journey empty wagons, in a very hilly district—High Peak of Derbyshire,—with less than one ton of soft smoky coal. Will be pleased to give "J. W." any further information.—G. HAYWOOD.

BRAKE-WHEELS, WINCHES, ETC.—(1.) Are there any reliable rules for the design and construction of brake wheels and straps; also, what is the method of calculating the strains on the above as applied to cranes, crabs, and winches? (2.) Is there any formula for finding the diameter and width necessary for a roller on jib bottom to travel on roller path? (3.) What is the method by which the strains on the sides of crabs, winches (C. I. and W. I.), A, circular and other designs of frames, are worked out? Any information on the above would greatly aid.—F. W.——A.—(1.) The brake wheel should, if possible, be upon the same axle as the chain drum, so that the jerks and jars of lowering rapidly may not come on the teeth of the gear wheels. In apprenticeship days we remember, however, a crane having no friction drum, in which, by winding a piece of gasket round the slow-motion shaft, we fashioned a very efficient if noisy lowering apparatus for weights, even up to 10 tons. If the brake wheel is made of

Fig. 1



about the same diameter as the pitch circle of the toothed wheel on drum axle, it will generally be large enough and less cumbrous than one of greater size. Next decide in how many revolutions, or in what fraction of a revolution, you wish to be able to stop the drum axle when lowering full speed, and find the distance described by the periphery of the brake wheel in that number of revolutions. Now the total frictional resistance to be caused by the band brake is—the total work to be done in stopping the falling load—divided by this length. The total kinetic energy of the falling load will be expressed in foot-pounds, and therefore division by feet will give pounds of resistance at the periphery of the brake wheel. Looking at Fig. 1 it will be seen that the two ends of the band, when the lever is depressed, are pulling in opposite rotative directions—T_2 and T_1. Therefore the *difference* of these two tensions is equal to the frictional resistance to motion at the periphery of the brake wheel. The ratio expressing the difference of tension depends upon the proportion which the arc of contact $T_2 C T_1$ bears to the whole circumference, and upon the coefficient of friction, and is found as follows:—

$$K = \frac{T_2}{T_1} = \epsilon^{\mu\theta}$$

K being the ratio of the tensions in the two parts of the band; $\epsilon = 2{\cdot}71828$, or the base of natural logarithms; μ the coefficient of friction; and θ the angle $T_2 D T_1$ expresed in circular measure. The above formula may be expressed in common logs. as follows:—

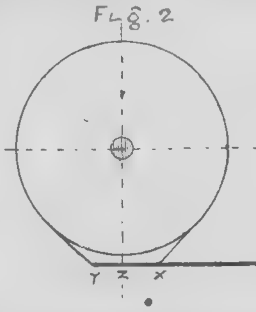
Log. $K = 0{\cdot}007578\,\mu\,\theta$ (in this case θ is expressed in degrees); μ for W.I. on C.I. $= 0{\cdot}18$. Now to find tensions on tight and loose sides of band respectively: Let P = the resistance due to friction at circumference of pulley, then as before stated $P = T_2 - T_1$ and $P = 126{,}000\,\frac{H}{dN}$ where H is horse-power equivalent to the circumferential velocity of the wheel × the resistance required at its periphery; d = diameter of the wheel in inches, and N = the number of revolutions per minute. Now the tension at the tight side of band

$$= T_2 = P \times \frac{K}{K-1}$$

$$\text{and } T_1 = P \times \frac{1}{K-1}$$

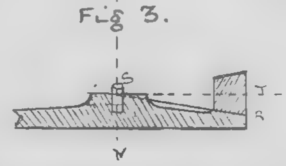
Now make the thickness of the band as great as is consistent with proper flexibility, and its breadth great enough to give the sectional area required for tensile strength.

Fig. 2



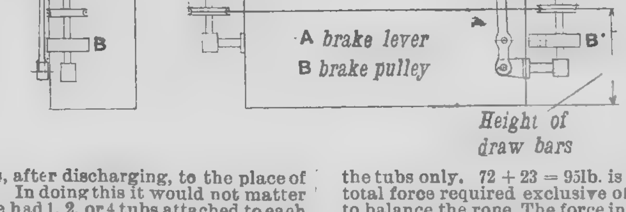
The arrangements of levers for tightening the band are innumerable. In Fig. 1 the slack end (or tight end, according to taste) is brought down to the axle on which the lever turns, B being fixed to the standing part of the crane. Fig. 2 shows a differential arrangement in which the distance Z Y is somewhat less than Z X, so that when the handle is depressed, X tightens more than Y loosens the band. This arrangement gives a longer handle and more power in "applying the strap." (2.) I have not seen a special formula for jib bottom rollers. Failing the good old practice of measuring up existing rollers which have served, and adopting same proportions, I should find the stress normal to the line of contact of the rollers and their bed assume this line of contact to be, say, 1⁄16in. broad in actual fact, and from the crushing resistance of cast iron calculate a suitable length of roller. Of

Fig. 3.



course this length would be to distribute between any convenient number of rollers. You might have them cast in chills and ground true with advantage. In any case they must be conical as in Fig. 3, as one cone will roll on another; but a cylinder will not roll round one of its ends on a plane. This is ensured by making S R, the direction of the line of contact, pass through S, the point of intersection of the two axes T S, V S. (3.) Unless you explain what strains on what sort of crabs and winches you wish to calculate, it will be difficult to cover them in the limits of an answer. The ordinary rules for compressive, tensile, and cross-breaking strain should suffice for the purpose.—T. J. B.

COAL MINING. — Will some reader of THE MECHANICAL WORLD kindly say how many tubs should be run each journey to work an incline of 1 in 14 and 1100ft. long, so arranged that the full tubs going down will bring up the empty ones? Weight of tubs, full, 15cwt.; empty, 5cwt. each; would two tubs each journey be sufficient? Which would be the best to lower the tubs with—a brake drum or a horizontal brake pulley? Please say how to calculate the weights for working inclines of various gradients when arranged as the above.—AUTOMATIC.——A.—If I understand the question of "Automatic" rightly he desires to work the tubs both loaded and empty on the same incline of 1 in 14, side by side on two sets of rails, the full tubs at 15cwt. each to run down one set of rails to the place of discharging, and in so doing to draw up the



empty tubs, after discharging, to the place of re-loading. In doing this it would not matter whether he had 1, 2, or 4 tubs attached to each end of his rope, so long as he kept the same number of tubs attached to each end, as the ratio would remain the same as 1 is to 3, since the empty tubs are 5cwt. each. The resistance on a level is estimated at about $\frac{1}{240}$th part of the insistent weight, so that the resistance of the empty tubs would be $\frac{1}{240}$th + $\frac{714}{10{,}000}$th of the whole weight of the empty tubs. Taking two tubs as proposed by "Automatic," the power required to draw up two empties would be $\frac{1}{240}$th of 10cwt. = 4·6lb + ($\frac{7{\cdot}14}{100}$th 10cwt. = resistance of incline = 80lb.) = 84·6lb. required to draw two empty tubs up the incline. We will next consider what power will be required to draw two full tubs down an incline of 1 in 14, velocity not taken into account. Again, $\frac{1}{240}$th part of the whole weight as per above on lev = 0·00417 of the whole load—viz 13·8lb., gravity of plane 1 in 14 = $\frac{7{\cdot}14}{100}$th. Then $\frac{7{\cdot}14}{100}$th parts of 30cwt. = 240lb., and 13·8lb. - 240lb. = 227·8lb. as the force that may be used in drawing up the empty tubs on the other rails. Then 227·8lb. − 84·6lb. = 143·2lb. is the excess force which "Automatic" will have to resist to prevent the running away of his loaded tubs down the incline. If "Automatic" thinks fit he might use a horizontal brake pulley, as proposed, upon one of his shafts on which his pulleys are placed, either above or below the grooved pulleys round which his wire rope would pass, as shown in Fig. 1. He would not require a fixed brake drum, as he would not have a very great force to overcome; but it may prove helpful to him to give the rule for a rope passing round a fixed pulley, shaft, or capstan. A rope passed half-a-turn round a fixed object will resist 3 times the weight applied for every 1lb. applied; one and a half turns, 9 times the weight applied; two and a half turns, 27 times the weight applied; or, *vice versa*, would take that power to cause motion. "Automatic" might make a fixed grooved pulley to have about two-fifths of a turn of his rope round somewhere between his two movable pulleys, and so make the apparatus entirely automatic: but the loads would have to be worked to a nicety. A half-turn would be rather too much, as he has not quite 3 times the power of his resisting force of the empty tubs, as his power and the resistance will be about $\frac{227{\cdot}8\text{lb.}}{84{\cdot}6\text{lb.}}$ or about 2·69 times the resistance.—J. H. PILKINGTON.——A.—The first thing to determine is the weight of 1100ft. of steel wire rope, and this is determined by the diameter or circumference of a rope strong enough to stand the greatest strain brought upon it. The greatest strain will be when the maximum number of tubs, fully loaded, and running at their highest speed, are suddenly brought up by applying the brake to the brake wheel. Suppose the greatest number of tubs ever used is six, and the maximum speed which these are allowed to attain is 9ft per second, or about 5 miles per hour, and suppose these are brought up within a minimum distance of 40ft. Now, six loaded tubs, or 90cwt., travelling at 9ft. per second, have a "kinetic" or stored energy of $\frac{1}{2}m\,v^2$, m being the mass expressed in lb. or cwt., and v the velocity of that mass. $\frac{1}{2}m\,v^2$ = here

$$\frac{90 \times 81}{2} = 7290\text{ft.-cwt.}$$

This is the measure of the work done in setting 90cwt. in motion with this velocity, and is also equal to the work to be done in stopping it. This 7290ft.-cwt., then, divided by the distance in which it is stopped, will give the strain on the rope in cwt., $\frac{7290}{40}$ = 182cwt. Using a factor of safety of 3 for the rope gives us 182 × 3 = 546cwt. as the strength we must look out in a table of rope strengths to get the diameter or circumference and weight of the steel wire rope. These we find to be 1in. in diameter and 1·58lb. per foot run. The total weight of the rope, therefore, is 1100 × 1·58 = 1738lb. This weight must be balanced at starting by an excess of the weight of the full tubs over that of the empty ones. The rope must run on carriers or grooved rollers, however, and the friction at starting of these and of the tubs must be allowed for. The total weight on all these carriers is 1738lb. This, multiplied by the coefficient of statical friction, or friction of starting, will give the total friction to be overcome in all the carrier wheels. This coefficient may be taken at 0·12. Now, 1738 × 0·12 = 208lb. is the statical friction caused by each axle on its bush; but as the carriers will be, say, 9in. in diameter, and the axles only 1in. in diameter, the rope has a mechanical advantage of 9 over the arrangement, and $\frac{208}{9}$ = 23lb. is the pull on the rope due to this cause. The force required to start carriages on a railway loaded and unloaded has been ascertained by experiment, and supposing your tramway and tubs in fair order, we may assume it here as about 18lb. per ton hauled. Taking (for trial) four tubs as the mean of six, the maximum, and two the minimum, the weight of the whole eight will be four tons. 18 × 4 = 72lb. is therefore the pressure in the direction of the incline which the full tubs must exert for overcoming the resistance of the tubs only. 72 + 23 = 95lb. is therefore the total force required exclusive of that needed to balance the rope. The force in the direction of the grade caused by a given weight rolling down 1 in 14 incline will be quite nearly enough 1⁄14 the weight. 95 × 14 = 1330lb. is the amount, then, by which the descending tubs must outweigh the ascending, due to the carriers and rolling friction. Add to this 1738lb. to balance the rope, and we get 3068lb. or 27·4cwt. as the required excess weight on the descending tubs. Evidently three tubs full will supply this weight; but if the calculation be corrected again for three and for two tubs it will be seen that three fulfil the requirements, but that two will not. I should prefer a horizontal brake pulley for working such an incline, supposing that one of sufficient diameter could be fitted. This should have a dovetailed rim fitted with hard wood blocks for the ropes to run on and grip. Best flexible steel wire rope should be used. The working of the above example, it is hoped, will explain the method.—T. J. B.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed

30th January, 1893.

1976 SAFEGUARDING and PRODUCING SAFEGUARDED PIPING and OTHER FLUID CONTAINERS, AGAINST the EFFECTS of FROST or OTHER LIKE EXPANSIONS. E J Warmington.

1981 STEAM and WATER COCKS. J Allmark.

1987 INDICATOR for USE on BOARD SHIP. C Colpitts.

1995 HYDRAULIC PACKING PRESSES. H Shield and W Critchley.

1997 FURNACE for STEAM GENERATORS. W D Grimshaw.

2010 ELECTRICITY METERS WORKED from a CENTRAL POSITION. W H Scott.

2011 PAGING and NUMBERING MACHINES. A Partridge.

2017 HAND TOOL for CUTTING HOLES in STRONG STEEL or OTHER METAL PLATES. B Haigh.

2018 MACHINES for STITCHING BOOKS, PAMPHLETS, ETC. W Beecroft.

2024 PUMPS and BLOWERS. P F Oddie.

2031 TREATMENT of IRON and STEEL to PROTECT the SAME AGAINST RUST. E Jokl and S Roudnitz.

2034 TELL-TALE MECHANISM for RECORDING the ATTENDANCE of WATCHMEN. G J S Hopkins.

2040 UTILISING the RISE and FALL of the TIDE or TIDAL RIVERS. J F Gilbert.

2046 APPARATUS for BORING TUNNELS. H H Lake. (*R W Dinnendahl*, Germany.)

2050 GAS-LIGHT APPARATUS. J H Kerr.

2052 WATER and WIND MOTORS. A A Raubold.

2053 STEAM and OTHER ENGINES and BOILERS. R McGlasson.

2055 SAW BENCHES. A Bridgman and D House.

2057 THERMOMETERS for INDICATING the TEMPERATURE or REFRIGERATING CHAMBERS, ETC. W Taylor.

2058 FURNACES of STEAM BOILERS. W T Smith.

2059 TELEGRAPHY.* A Heil.

31st January, 1893.

2081 OBTAINING SILVER and GOLD from THEIR SOLUTIONS. J R Wylde and others.

2082 PAPER BAGS. N Watson.

2083 NAVIGABLE VESSEL. A H Valda.

2084 TYPE-WRITING MACHINES. C M Newton.

2085 OIL and GAS ENGINES. J E H Gordon.

2089 GAUGES or WATER-LEVEL INDICATORS for STEAM GENERATORS. T Elcoate.

2092 APPARATUS for PROCURING MOTIVE POWER. W Jones.

2093 HYDRAULIC PACKING PRESSES. H Shield and J Howarth.

2094 REDUCING VALVE. J C Stewart.

2095 TAPS for WATER and OTHER FLUIDS. W Thomson and B Kelvin.

2100 AUTOMATIC WEIGHING MACHINES. E H Beckett and C W Roberts.

2106 SAFETY MINING CAGE. T L James.

2109 APPARATUS for PURIFYING WATER. H Collet.

2110 GAS ENGINES. C W Dixon.

2117 JOINTS for UNITING METAL PARTS of MACHINES.* A W Kirsch-King and C E Funk.

2119 TREATMENT of METALLIC ORES.* A J Boult. (*C G Richardson* and *A B English*, Canada.)

2122 APPARATUS for GRINDING FILES and BLADES. T Crosley and F Evans.

2123 STEAM GENERATORS. W C Higgins.

2124 LATHES or MACHINES for MAKING SCREWS.* W P Thompson. (*C M Conradson*, United States.)

2129 PRODUCING MICA RINGS or DISCS SUITABLE for INSULATING PURPOSES. R Haddon. (*C W Jefferson*, United States.)

2132 SIGNALLING on RAILWAYS. S Machin and A J Bell.

2134 POROUS VESSELS or POTS and DIAPHRAGMS for SECONDARY and PRIMARY BATTERIES. G Lentz.

2139 DRAWING PINS. G Simmins. (*W F Brett*, New Zealand.)

2145 DYNAMO-ELECTRIC MACHINES.* H H Lake. (*R Lundell* and *E H Johnson*, United States.)

2147 RAILWAY SLEEPERS or CROSS TIES.* C A Gildemeyer and O Twitchell.

2150 SHEARS or APPARATUS for CUTTING UP SHEETS and RODS. F H Eversmann.

2155 SAPONIFYING or MIXING TARS, OILS and HYDRO-CARBONS for HEATING and LIGHTING PURPOSES. C A Sahlstrom and E Parr.

2156 MACHINERY for the MULTIPLE BORING of BRUSHES and BROOMS. A Foster.

2159 ELECTRIC ARC LAMPS. J H Rose.

2161 HEATING LIQUIDS by ELECTRICITY. L B Miller and M W Woods.

2162 MACHINES for SAWING or CUTTING METALS.* C Frémont

2163 VALVE GEARS for STEAM ENGINES.* C F Littlejohn.

2164 STEAM ENGINES.* C F Littlejohn.

2167 APPARATUS for REGISTERING TELEPHONE CALLS. L Kahn.

1st February, 1893.

2170 STEAM ENGINE. S Baader and others.

2173 COUPLING PIPES to COMPENSATE for VARIATION in LENGTH or POSITION DUE to DIFFERENCE of TEMPERATURE. H T Harris.

2176 SIEVES and AGITATING MECHANISM THEREFOR.* O Schnelle.

2182 APPARATUS for TRANSMITTING MOVEMENTS or INDICATIONS by ELECTRICITY. T O'Brien.

2183 GAS PRESSURE INDICATORS and REGULATORS. J Purcell and S Carnaby.

2190 FIELD MAGNETS. C B Crawshaw and C Wray.

2191 TELEPHONE TRANSMITTERS. H A C Saunders and A C Brown.

2192 REGENERATIVE GAS LAMPS. A Heussy. (*L Fremaux*, France.)

2193 HYDRAULIC PACKING PRESSES. H Shield and J Howarth.

2194 INSTRUMENT for MEASURING ANGLES, ETC., and LEVELLING and PLUMBING, ETC. W J Painter.

2197 SELF-LOCKING COTTER PIN. S Richards.

2198 BALANCES. W Thomson (Baron Kelvin).

2199 INSTRUMENT for the MEASUREMENT of ELECTRIC CURRENTS. W Thomson (Baron Kelvin).

2202 PHOTOGRAPHIC PRINTING by ELECTRIC LIGHT. J E A Gwynne.

2203 ALTERNATING CURRENT ARC LAMPS. J E A Gwynne.

2212 DESTRUCTOR and OTHER FURNACES. J J and T F Meldrum.

2219 AUTOMATICALLY DELIVERING a SUPPLY of GAS in EXCHANGE for a COIN of FIXED VALUE.* J Steele and J W Brierley.

2230 BOILER FURNACES for FACILITATING the REMOVAL of ASH and CLINKER. W A Granger. (*W Lewis*, Australia.)

2231 SUPER-HEATING of STEAM for STEAM ENGINES. W Schmidt.

2241 HIGH-TENSION BATTERY. C A J H and H E R Schroeder.

2243 SELF-EXPANDING and WEDGING BOLT and CUP for STRONG ROOMS, IRON SAFES, ETC. T W Wilson.

2247 PRODUCTION of BLOCK FUEL GAS from REFUSE MATERIALS. J C W Stanley.

2248 STEAM BOILER FURNACES.* H C Ashlin.

2261 MOULDING MACHINE. H Martin. (*H A Billings*, United States.)

2266 DRILLING MACHINE. P Willis. (*D Baker*, United States.)

2269 BUCKET ELEVATORS.* J F A Filler.

2270 APPARATUS for FINDING the RANGE or POSITION of DISTANT OBJECTS. H H Lake. (*The American Range Finder Company*, United States.)

2272 ELECTRIC-LIGHT HANGERS or SUPPORTS. H L Holt.

2nd February, 1893.

2282 LATHE CHUCK. T Barter and G Crees.

2285 APPARATUS for SIGNALLING TRAINS on RAILROADS. D Schofield.

2290 VARIABLE SPEED GEAR. A M Laws.

2293 FIRE DOORS for FURNACES. D B Morison.

2300 CINDER SIFTERS. R O Templeton.

2304 MECHANICAL STOKERS. R H Williamson and J Dyson.

2318 ELECTRIC TOOL.* G H Williams.

2319 DEVICES for PREVENTING RAILWAY CARS FROM LEAVING the RAILS.* C W McBryer.

2320 ELECTRO-CHEMICAL CEMENTATION for SEPARATING COPPER FROM SOLUTIONS by MEANS of IRON. R Conedera.

2321 SECTIONS for GIRDERS or RIBS. H C Hall.

2329 MANUFACTURE of WHITELEAD ELECTROLYTICALLY. J C Richardson.

2331 SECONDARY ELECTRIC STORAGE BATTERIES. N H Edgerton.

2334 ELECTRIC INCANDESCENT LAMPS. E Bailey and G M Gordon.

2339 STEAM ENGINES. R S Boyer.

2341 GEAR WHEELS. C Lock.

2342 SHAFTS and AXLES. C Lock.

2346 COCKS and BALL VALVES. E J Cheyney.

2349 TINNING of ARTICLES MADE of CAST IRON. A J Boult. (*Messrs. Wolf, Wetter and Jacobi*, Germany.)

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to SIR H. READER LACK, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

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FRIDAY, FEBRUARY 24TH, 1893.

The Forging of Round Shapes

A MACHINE for manufacturing rolled forgings has been brought out in the United States. It has been designed and built for rapid and accurate work, and being rotary in all its movements no time or power is lost in the return of the dies to their working position. The machine, which is made by the Electrical Forging Company, of Boston, Mass., in different sizes, for the smallest to the largest and heaviest kind of work, may be worked at any speed, according to the nature of the work. It is quickly and easily adjusted, and is automatic in all parts, and the No. 3 size machine turns out round shapes from ½in. up to 6in. long, and from ½in. to 1in. in diameter. The American paper which illustrates but does not describe this machine, mentions that the scope of this type is very wide, as a great variety of things now produced are made of iron or steel of low carbon, in order that they may be turned out economically. By this process, however, it is said that highly-carbonised steel may be worked equally as well as iron or soft steel. This ensures increased strength, an advantage of great importance in all kinds of work. It is within the range of these machines to roll successfully, steel of the highest grade of crucible down to the open-hearth and Bessemer steel; whilst copper and brass can be similarly treated. It is claimed that these machines stand alone in the matter of producing rolled forgings of irregular shape without leaving them hollow or piped, and that the articles rolled, no matter what shape, are perfectly solid. Among some articles mentioned as made by these machines may be cited steel handles of all sizes and shapes. These, hitherto invariably made on the turning lathe, may now be produced by this process at a saving of 99 per cent. in labour, it being possible to roll 100 perfect handles in the time required to make one by former methods, whilst, there being practically no waste, a saving in metal is also effected. Anti-friction steel balls from ⅛in. up to 2in. diameter are made rapidly and accurately on this method of rolled forging. A red-hot steel bar is inserted between the revolving dies, and for every revolution of the latter a ball is forged, or a conical screw, a chair screw, a bolt with thread and head complete, a boiler rivet, tiny calks, or a spindle or taper may be produced.

The Cost of the Electric Light.

THERE is probably no question upon which so wide a divergence of opinion exists as that of the cost of the electric light; not the cost of production, but the actual amount which the user has to pay. It may be, after having the wires put in and the lamps installed, that the consumer undertakes to pay a fixed rate per lamp per annum, an arrangement which is satisfactory to some, but is considered too expensive by others who may only require the lamps alight two or three hours daily. In a case of this nature the user knows perfectly well what amount he will be called upon to pay at the end of the quarter. On the other hand, the customer may pay for the light at a definite charge per unit of current consumed according to the record of the meter installed on his premises. This seems to be the most satisfactory method, and if the user takes care not to keep alight lamps which are not actually required, the cost to him should be reasonable, considering the advantages which electrical illumination possesses over gas lighting. It often happens, however, that lamps are allowed to burn when they are not needed, and the result in some cases is, when the quarter's bill is received, that the amount due is regarded as high. This is only a natural consequence when proper regard is not paid to economical use. The cost to the consumer thus varies; but taken generally, it comes to about twice the price of moderately cheap gas. Still, there are those who will maintain that the electric light is the poor man's light, although there are different classes of poor men. Mr. W. H. Preece, who is a valiant supporter of the view that electric lighting by glow lamps is as cheap as gas, is now engaged in determining the best and cheapest method of fitting up small tenements so as to bring the light within the reach of the poor. It is to be hoped that he will succeed in this endeavour. The reduction in the price of incandescent lamps on the expiration of the lamp patents at the close of this year will assist him, but only to a slight extent. It is more in the cost of the wires and in installing them that economy is necessary to enable Mr. Preece to accomplish the object he has in view. Let us hope that he will be able to do so.

Ruthenium.

THE metal ruthenium has lately been shown by Professor Joly to possess some very remarkable properties. In addition to being one of the rarest of metals, it presents the most original characteristics of all the known elements. Professor Joly has submitted to the French Academy of Sciences several samples of a red colouring substance, resulting from a combination of other compounds with the metal, giving a dyeing power comparable with that of the richest colouring materials derived from coal tar—with fuchsine, for example. One five-millionth of this substance is sufficient for colouring water; it dyes silk directly, and the colour thus obtained is fixed. The chemical reactions of this new colouring product are equally interesting, acids causing it to turn yellow and alkalines to bring it back again to red. Unfortunately the rarity of the metal which enters into the composition of this substance is inimical to its use in industry. It is, in fact, a scientific curiosity of great interest; for here we have a metal playing the *rôle* of carbon in a substance which has all the properties of an organic material.

A New Mining Hoist.

OF the numerous electrical concerns in the United States, probably the General Electric Company is the one which devotes most attention to the application of electricity to mining. The company has now brought out a new mining hoist, the special object of which is to obtain a wide range of lifting speed. The drum is of unusually large diameter, and is connected by means of intermediate gear to the armature shaft of a 30H.P. electric motor. The controller for the motor is similar to that generally used on the electric tramcars in the States, and is arranged conveniently within reach of the operator, and to the right of the levers. The latter can then be operated with the left hand, and the controlling switch with the right hand. The control is on the "series" system, the speed being increased or decreased by the movement of the switch handle. The hand brake extends almost entirely round the drum, which is thrown into operation by a clutch actuated by the second lever. This hoist will raise loads of 11½cwt. at the rate of 600ft. a minute, and also loads of 1cwt. at a speed of from 20ft. to 30ft. a minute. The motor is arranged on its own bedplate, which is bolted to the bedplate of the hoist proper.

State of the Skilled Labour Market.

FROM the memorandum prepared by the Labour Correspondent to the Board of Trade we find that during the past month there has been a slight increase in the number of strikes, there having been 38 recorded as against 24 in the month preceding. With two or three exceptions, however, these disputes have not been of great importance, and the number of workers thrown out of employment thereby has not been large. The principal strikes of the month took place in the iron and steel trades (6), shipbuilding (6), dock labour (6), coal-mining (4), building trades (4), and the remainder among miscellaneous industries. So far as the general state of employment for skilled labour is concerned, the returns of the chief trade unions which send in reports show a slight improvement. The temporary causes which operate to throw large numbers of workmen out of employment at the end of the year have disappeared, and from this cause rather than from any definite improvement in the state of trade there is this month a slightly decreased percentage shown of men on the vacant books of those societies. In all 23 unions of skilled trades have reported to the Board of Trade. These have an aggregate membership of 279,577, of which 27,845 are out of work. Last month the total of unemployed members reported in the same societies was 28,453. There is thus a net decrease of 608. The proportion per cent. reported for the present month is thus 9·96 as against 10·2 in the previous month. This improvement is in itself so slight that no specially hopeful anticipations can be based on it. The most that can be hoped is that, as in some of the most important industries there is a decrease in the number of those out of work, and in others no increase of any weight, the lowest point has been reached. The various branches of the engineering trade are those which show the most improved figures, while in shipbuilding things remain exactly as they were. The same may be said of the building trades, in which there is no change. The North of England coal trade is in a very dull condition at present, and both in Durham and Northumberland many collieries are not only working shorter time, but in some cases day hands are being paid off. Of the 23 unions of skilled trades which sent in reports as to the condition of their respective labour markets, the general remarks made show 14 as "bad," six as "moderate," and three as "good."

Electric Lighting in Berlin.

IT appears that the development of the electric light in Berlin does not progress in anything like the same ratio as in London, which has greatly outstripped the German metropolis. This fact is clearly shown in a report just issued by the administration of the Berlin municipal gasworks, and which refers to the working year ending 1st March, 1892. The report, which points out the influence which the increasing adoption of the electric light has had upon the consumption of gas, contains various tables showing the use of both illuminants in the different districts forming the city The number of arc lamps in private use at the end of the year mentioned was 7876, as compared with 6023 in the previous year; and of incandescent electric lamps 140,276, as against 108,258 in the corresponding year. In addition to these, some 160 arc lamps were employed for street lighting, whilst 192 motors were operated from the central stations, as compared with 89 motors in the preceding year. It will be evident that progress is only taking place steadily, and in a city, too, which four years ago was in a more advanced stage of electric lighting than the English metropolis.

An Eight Hours Day in the Engineering Trade.

WHAT is likely to prove a very interesting experiment was inaugurated on the 20th inst. at the works of Messrs. Mather and Platt, Salford, Manchester, by the introduction of an eight hours day. The subject, at the request of the employers, has been under the consideration of a committee of the workmen since December last. The committee was asked to try to devise a scheme which, if successful, might be recommended to the engineering trade as a whole; but owing to difficulties in connection with the working and payment of overtime, and the payment of double shifts of men (when necessary), they were unable to come to a unanimous decision on the matter. On Saturday last, however, Messrs. Mather and Platt issued an address to the men, in which they state that they are prepared to take upon themselves the risk of a twelve months' experiment, providing they are at liberty to revert to the old system if it does not succeed. This was agreed to, and on Monday last the new arrangement was begun. The following time table, suggested by the Amalgamated Society of Engineers, has been adopted:—Monday, Tuesday, Wednesday, Thursday, and Friday, 7-45 to 12, 1 to 5-30; Saturday, 7-45 to 12. This division of hours may be modified as experience determines. Many of our readers will no doubt remember that Messrs. Mather and Platt were the first firm in Manchester to voluntarily adopt the nine hours day. We look forward with much interest to the result of this experiment, which we trust will be satisfactory to all concerned.

MESSRS. WILLIAM GALLOWAY AND CO., Gateshead, have again had their tender for the supply of cut steel nails, brads, and tacks, during the ensuing year, accepted by the War Office. This is a renewal of a contract Messrs. Galloway and Co. had last year.

On Moduli of Sections.

[CONTRIBUTED.]

A MODULUS of a section is defined as that function of the dimensions of the section which is proportional to the moment of resistance of the section. Most text-books fail to show the student how these moduli are obtained, thus causing him much trouble if he be curious to know how they are established. It is proposed here to show in a simple manner how these moduli are worked out.

A modulus having been defined, we will now proceed to establish a preliminary equation.

Imagine a bar—for simplicity a square-sectioned bar—to be rigidly fixed by one end in a horizontal position, as shown in Fig. 1. The free end of the bar is loaded by a

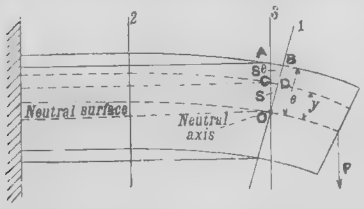


Fig. 1.

force P, which produces a deflection from the horizontal, and in consequence of this deflection the upper fibres of the bar are extended, whilst the under fibres are compressed. In the figure the deflection is shown much exaggerated in order that the result may be more clear. As stated, then, the upper fibres are in tension, and the under fibres are in compression; hence there must be some fibres, or plane of fibres, which are neither in tension or compression.

This plane of fibres is called the "neutral surface." In order to know more of the forces acting in the single fibres, and which have produced this extension, respectively compression, of the bar, we imagine two planes—viz., I. and II.—to be laid through the bar, perpendicularly to the plane of the paper and to the neutral surface. No. II. plane is to pass through the undeflected part of the bar, No. I. passing through a bent portion. That point or line where Plane I. intersects the neutral surface is called the "neutral axis."

In order to find the amount of compression, or preferably extension, we imagine a third plane, perpendicular to the plane of the paper and passing through the neutral axis O, to be drawn parallel to Plane II. Then A B and C D gives us the amount of extension which has taken place, at distances e and y from the neutral surface. Now we must premise that the deflection of the bar is not very great, then one can suppose A B to be parallel to C D. Then from geometry we obtain this proportion:—A B : C D = O B : O D.

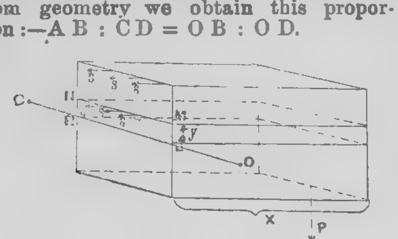


Fig. 2

Let us denote the extension A B by the letter λ_e, and the extension C D by the letter λ; also the forces which have produced these extensions by the letters S_e and S respectively. The extensions must be proportional to the forces producing them, consequently by placing the above values in the above proportion we obtain in order the following proportions:—

$$\lambda_e : \lambda = e : y$$
$$\lambda_e : \lambda = S_e : S$$

Since the left-hand sides of these proportions are equal, therefore the right-hand sides must also be equal, and thus $S_e : S = e : y$. This proportion tells us that the forces acting on the fibres are proportional to their distances from the neutral surface. Moreover, these proportions would tell us, if graphically represented, that the points of application of the forces S_e and S lie in a straight line with the axis O. From the above proportion we obtain the equation—

$$S = \frac{S_e}{e} y \text{ .... (I.)}$$

Let us imagine the end of the bar, upon which the force P is acting, to be cut off by the Plane I. and placed perspectively before us; then Fig. 2 represents it.

Now, in order to prevent this prism from turning on the axis O O, under the influence of the force P acting with the lever arm X, we must attach so many forces acting at distances y_1, y_2, y_3—e until equilibrium is obtained.

Let us imagine one of these forces to be acting in every unit of area, then in the parallelogram L M N R there will be total force of f S, where f=area of the parallelogram. This force acts with the lever arm y, therefore the moment of this force is f S y. In every line parallel to the neutral axis of the bar, just such a moment acts and in the same direction. The entire moment, then, will be the sum of all these small moments, and this acts in a contrary direction to the force P with the lever arm X; hence we have $\Sigma f S y = P X$. For S we can substitute its value in Equation I., hence we obtain a new equation—namely,

$$\Sigma f \frac{S_e}{e} (y)^2 = P X.$$

The factor $\left(\frac{S_e}{e}\right)$ will appear in all the sums, therefore we can write it in front of the letter Σ.

The expression $\Sigma f (y)^2$ is only dependent on the form of the section, and can be calculated for every section. Let us denote the result by the letter I_g; then the equation will be written thus:—

$$\frac{S_e}{e} I_g = P X,$$

or written otherwise we obtain $S_e \left(\frac{I_g}{e}\right) = P X$.

Let us also denote the factor $\left(\frac{I_g}{e}\right)$ by the letter W, and the equation becomes S_e W = P X.

Now the force S_e must not exceed the safe stress k per unit of sectional area, hence we obtain the important equation:

$$W k = P X \text{ .... (II.)}$$

The expression $\Sigma f y^2 = I_g$ is called the moment of inertia of the section, and the expression

$$\frac{I_g}{e} = W$$

is sometimes called the moment of resistance, but it is much more correct to call it the "modulus of the section."

Law I.—The neutral axis passes through the centre of gravity of the section. To prove this we reason thus: A force f S acts in every plane of the bar parallel to the neutral surface, and in a horizontal direction; then in order that a horizontal displacement of the prism should not occur the sum of all the horizontal forces must be nothing—that is, $\Sigma f s = 0$; or written otherwise,

$$\Sigma f \frac{S_e}{e} y = 0.$$

Now $\left(\frac{S_e}{e}\right)$ is not $= 0$, $\therefore fy = 0$.

The laws of the centre of gravity teach us that this equation expresses the fact that the axis O O, from which the parallel lines are counted, passes through the centre of gravity of the section.

(*To be continued.*)

It is estimated that there are in the United States, for each 100 miles of road, 20 locomotives, 17 passenger cars and 714 freight cars.

The Under-type Stationary Engine.—XXIV.

UNDOUBTEDLY the safety valve is the most important fitting connected with the high-pressure locomotive boiler, and there are so many types in the market that we find it somewhat difficult to make a selection. However, we give the double Ramsbottom safety valve the first place on the list, as this admirable type of valve is so largely adopted on railway locomotives. Fig. 50 shows a sectional view of the above-named valve. In this instance, the valves and funnels are made of brass, the tops of the funnels being suitably turned so as to form the seats for the valves; the U pipe and base are of cast iron; the pivot, eyebolt, link and lever are made of wrought iron. One pivot is forged with the lever, the other is loose and carried on a brass pin. The strong round steel spring is in tension; it has a hook formed on each end, one of which passes through the lever at the top, and the other end is threaded through the eyebolt. A safety link inside the spring connects the lever with the eyebolt, and a slotted hole for the top pin allows the spring to extend when the boiler is under pressure; the link would prevent any disastrous consequences in case the spring was to break. The advantages of the Ramsbottom valve are: Great simplicity, absence of means of tampering with the load, convenient funnels for the escape of the steam, the spring not subject to the action of the escaping steam, while a ready means is provided for ascertaining by a touch of the lever if the valves are working freely.

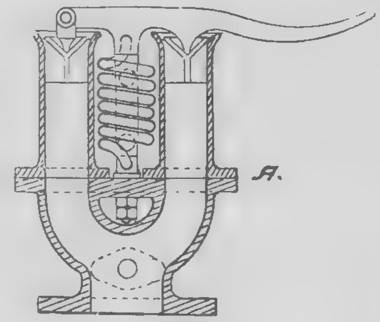


Fig. 50.

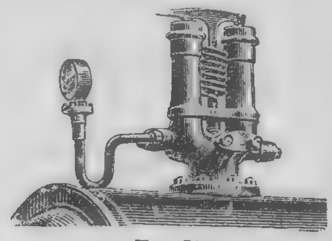


Fig. 51.

Mr. Webb gave some instructive information derived from experiment with locomotive boilers for the purpose of ascertaining the rate at, and extent to which, the pressure of steam could rise in such boilers after the safety valves had begun to blow off. "For this purpose," writes a contemporary, "Mr. Webb had fitted pieces of ¾in. and 1in. pipe just below the safety valve of one of the London and North-Western goods engines, the pipe in either case being fitted with a cock. The engine, with the brakes hard on, was run so as to get up a fire capable of generating steam as fast as when in hard work. The engine was then stopped, and it was found that the Ramsbottom safety valves always carried off the excess of steam, with but a rise of 6lb. above the pressure to which the valve was set. The cock was then opened in the ¾in. pipe, but this was found insufficient to carry off all the steam; the 1in. pipe, however, carried off the steam as fast as it could be made by this powerful boiler." In many instances the safety valve casing is made in one piece of cast iron, as shown in Fig. 51. The valves and seats are made of brass, and the seats are driven into the cast-iron funnels; but for the following reasons the type shown by Fig 50, where the funnels are of brass, and form the seats for the valves, are much to be preferred. In the former case, the brass seats will expand twice as much as the cast-iron when both the metals are subjected to the same temperature, and an undue compression and possible distortion of the brass seating will ensue. "The movable part of the valve being guided in its motion by the brass seating, if undue compression or distortion of the seating should take place, this critical part of the valve may be either irregularly guided, and therefore 'jammed,' or it may be 'nipped' or held fast. It is clear, whatever the precise result may be, that there is always in this construction a possibility of irregular agencies of this nature coming into play, and disturbing the mechanical accuracy of the valve."*

It is very useful to provide one or more branches near the base of the safety valve for supplying steam to a donkey pump or an injector, as the case may be, instead of drilling a separate hole in the boiler for this purpose. Fig. 51 shows three small branches cast on the base, one of which is made to carry the syphon and pressure gauge. The Ramsbottom valve is sometimes adopted with a single spring of square steel in compression; we have used both the types, but we prefer the ones shown by Figs. 50 and 51, with the springs in tension. Sometimes the two funnels of the Ramsbottom valve are carried straight down and bolted or cast to a round cover, which is made to serve as the lid of a raised type of manhole. Of course this reduces the height of the valve. The funnels at A in Fig. 50 are bolted to the lid, the eyebolt nuts are in the steam space, and two holes are cast in the cover to suit the positions of the valves.

There is another good form of spring valve similar to the Ramsbottom type, which is now used on some of the Indian and other railways. The valve consists of

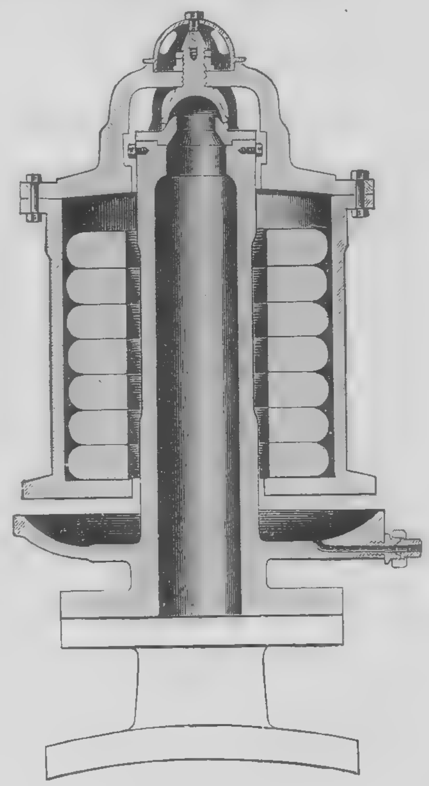


Fig. 52.

Under-type Stationary Engine.

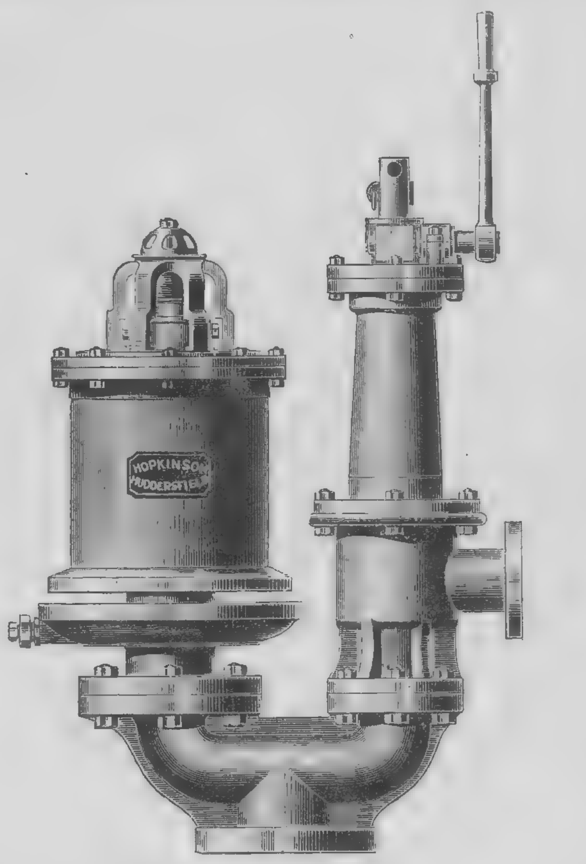


Fig. 53.

* "Safety Valves," by Mr. J. C. Wilson.

a central pillar carrying the easing lever on a brass pin at the top, a conical-shaped spiral spring in compression is disposed between the valve and the easing lever on each side of the central pillar, the two springs being pointed at both ends to enter centres drilled in the lever and the valves. It is a simple matter to use this arrangement of valve enclosed, so that the escaping steam may be conveyed outside the boiler-house by means of a pipe; and in this case the two springs are not exposed to the action of the escaping steam.

In many instances locomotive boilers are specified to have a deadweight safety valve in addition to a spring valve. Cowburn's, Turnbull's, or Hopkinson's are occasionally named. Fig. 52 shows the latest deadweight valve made by Messrs. J. Hopkinson and Co., of Huddersfield, which is self-explanatory. The novel and ingenious mode of arranging the weights inside the case, which together form the total amount of weight required on the valve, renders it a lock-up safety valve, and bids defiance to all tampering whilst the boiler is at work.

Messrs. Hopkinson also manufacture a duplex safety valve which contains some excellent features. Fig. 53 shows this valve, which comprises two separate valves on one branch—one valve 2in. diameter deadweight construction, the other a spring-loaded valve 3in. diameter, constructed in accordance with the requirements of the Board of Trade. Thus the total circumferential or lip area of both valves is equivalent to a single valve 5in. diameter. The duplex valve is more efficient, competent to discharge steam, and safer than a single valve of large diameter. It will be noticed from Fig. 53 that the spring valve is of the closed description; it may be made to blow off some 4lb. or 5lb. less pressure than the deadweight, so that the escaping steam may be conveyed away.

Safety valves of the Cowburn type, and also the deadweight patterns made by Messrs. Alexander Turnbull and Co., are illustrated in THE MECHANICAL WORLD for December 27, 1890.

(To be continued.)

Marine Boiler Furnaces.

(Continued from page 64.)

A FEATURE often claimed for the Fox furnace is additional evaporative efficiency, due to additional area of heating surface; but when it is remembered that the current of heated gases impinges on the inward corrugations, whilst the recesses formed by the outward corrugations are filled with gas comparatively stagnant, and also when it is remembered that the inward corrugations, by receiving the greatest heat, produce the greatest thickness of deposit, the efficiency of this additional surface is, in the writer's opinion, often over-estimated. In the Purves design the heated gas sweeps over nearly the whole surface, the only recesses being those formed by the ribs, and the same is practically the case in the Morison furnace. A frequently suggested arrangement is the simple reversal of the latter design, thus making the long suspension curve into an arch; but a little consideration will show that not only would the material forming the inward projections become overheated by the current of hot gas sweeping over the points, but the recesses formed by the arched surface would be filled with eddies of somewhat stagnant gas of a much lower temperature, and there can be little doubt that the evaporative efficiency of such a furnace would be less than a plain furnace of equal thickness.

A design which has been patented and re-patented is a furnace of barrel shape, either of equal thickness throughout or of varying thickness. The most successful furnace of this type at present being manufactured is that of Messrs. W. Arnold and Co., of Barnsley, and consists of a series of flanged barrel-shaped sections. This form is not suitable for marine work; and another design which has been proposed, consisting of a single length of barrel-shaped tube, would be still less so, and would be a very weak form of furnace.

There has been a host of other designs, evidently patented with a view of evading recognised successful manufactures and without any idea whatever of actual improvement, but naturally none of these have been adopted.

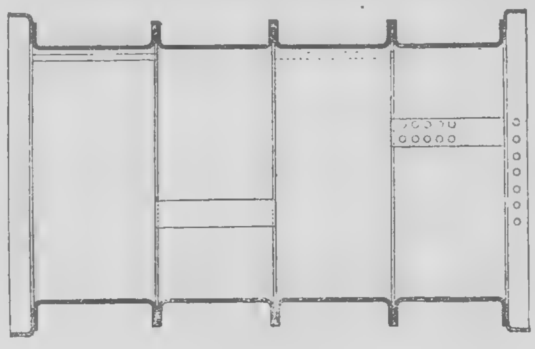


Fig. 2.

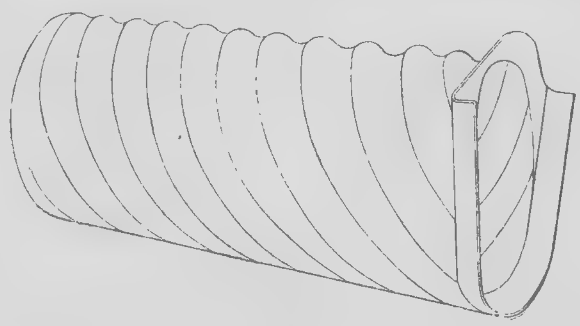


Fig. 6.

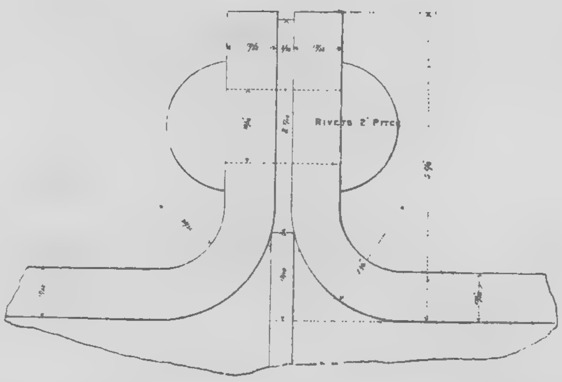


Fig. 3.

Marine Boiler Furnaces.

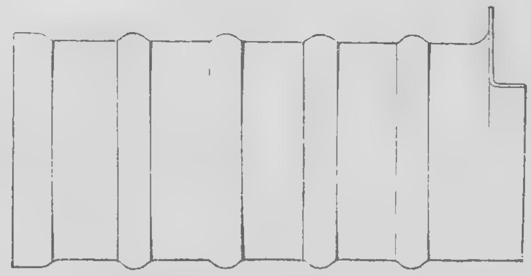


Fig. 7.

STRENGTH TO RESIST COLLAPSE.

The first experiments upon the collapsing strength of plain cylindrical tubes were those by Fairbairn; but as the greater number of these were made upon cylinders of small diameter, it is very doubtful whether the results obtained apply to flues of the dimensions in modern practice. Fairbairn's experiments have, however, been accepted by the majority of engineers as reliable, and the formula deduced therefrom has formed the basis of all rules for the strength of plain cylindrical flues. Fairbairn's formula was :—

$$P = \frac{806{,}300 \times K^2}{L \times D}$$

Where P = the collapsing pressure in lb. per square inch; K = thickness of the plate in inches; L = length of the flue in feet; D = diameter of the flue in inches.

This implies that the strength of a flue to resist collapse varies inversely as its length, and directly as the square of the thickness; but the latter may be questioned when the flue is of the proportions necessary for marine boilers. Both the Board of Trade and Lloyd's have adopted this formula with an alteration of the constants.

Board of Trade (steel furnaces) :— Working pressure per square inch

$$= \frac{99{,}000 \times K^2}{(\text{length in feet} + 1) \times D}$$

Lloyd's Register :—Working pressure in lb. per square inch

$$= \frac{89{,}600 \times K^2}{L \times D}$$

Although there is a limitation in both cases that the pressure must not exceed

$$\frac{8800 \times T}{D} \text{ for the Board of Trade,}$$

$$\text{or } \frac{8000 \times T}{D} \text{ for Lloyd's,}$$

which shows its empirical nature.

Valuable experiments on Adamson's rings were conducted by Messrs. Hall, Russell and Co., of Aberdeen, in 1882, and by Messrs. J. Howden and Co., of Glasgow, in 1887.

In Messrs. Hall, Russell and Co.'s experiment (Fig. 2), only one of the rings was collapsed, and after it had been temporarily strengthened the experiment was again proceeded with. Unfortunately, when the pressure was raised about 40lb. above that at which the ring had collapsed, the outer cylinder burst, and the experiment was abandoned. The coefficient given by the collapsed ring was :—

$$\frac{P \times D}{T} = 64{,}213,$$

the diameter being taken over the plain part, and on careful measurement the collapsed ring was found to be of less thickness than any of the others.

Messrs. J. Howden and Co. experimented upon a furnace formed with four rings, each 23in. long, and after each ring collapsed it was strengthened, and the pressure still further increased, until all the rings had been collapsed. Detailed particulars are given in Table I., the collapsing coefficient being 64,240, which agrees remarkably well with the results obtained by Messrs. Hall, Russell and Co., although it should be noted that the length of the rings in Messrs. Howden's experiment was 23in., and that of Messrs. Hall, Russell and Co. only 19in. A section of the flanges of the rings is shown in Fig. 3.

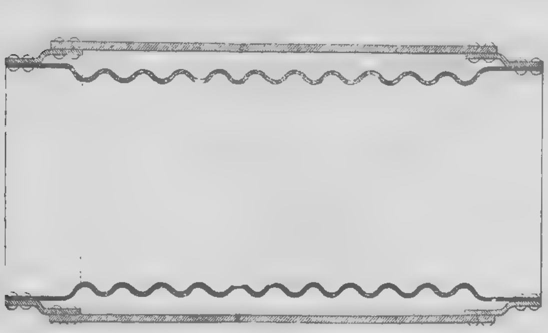


Fig. 4.

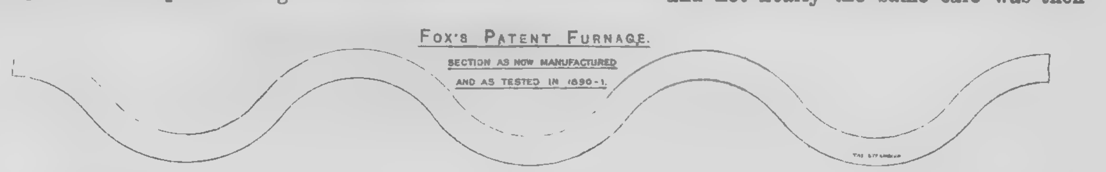
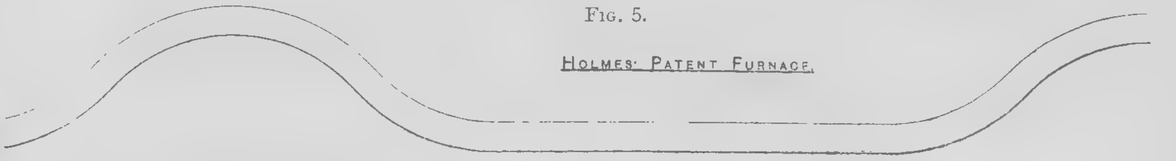


Fig. 5.



Marine Boiler Furnaces.

Fig. 8.

There is no actual record available of the mechanical tests of the steel from which these furnace were made, but they are understood to have been of the ordinary boiler quality manufactured at that time, and from 26 to 30 tons tensile.

The rule adopted by Lloyd's for furnaces made with Adamson's rings, with steel from 26 to 30 tons tensile, is :—

Working pressure in lb. per square inch

$$= \frac{1000\,(T - 2)}{D}$$

Where T = thickness of plate in sixteenths of an inch; D = diameter of furnace in inches, outside flats; and by the Board of Trade for steel from 26 to 30 tons :—

$$\frac{8800 \times T}{3 \times D}\left(5 - \frac{C \times 12}{67{\cdot}5 \times T}\right)$$

= working pressure in lb. per square inch; where T = thickness of plate in inches; L = length of distance between centres of flanges in inches; D = diameter of furnace in inches outside the flats.

Table II. gives the tests of the Fox furnace in 1882 and 1891.

In November, 1882, the first test was made upon a single tube of very mild steel, having a tensile strength of 22·7 tons per square inch. Until 1890 all the furnaces were made of this low tensile steel, and the results obtained, as compared with the furnaces made of the higher tensile, show, in the writer's opinion, that the step, however necessary from a commercial and competitive point of view, has not been successful in practice.

This test furnace was 6ft. 9in. in length by 3ft. 1⅞in. outside diameter, and had 13 corrugations 2in. deep from outside to inside, pitched 6in. from centre to centre. The furnace was enclosed in a steel cylinder specially made for the purpose, and connected to it by rivets, as shown in Fig. 4. Two Dewrance's gauges were used to determine the pressure in the space between the furnace tube and the testing cylinder, the space being filled with water, and the requisite pressure applied by mean, of a force pump. Before any pressure was applied the furnace was carefully gangeds and is reported to have been truly cylindrical throughout its whole length.

In considering the results of this test, however, it should be remembered that the manufacture was practically in its infancy, and not nearly the same care was then exercised either in the manufacture or the method of recording the tests. Consequently it may be safely assumed that if a Fox furnace made of the same steel were tested now the results would be better. For example, measurements were only taken at three points throughout the length of the flue, and it is recorded to have been absolutely cylindrical, although no other furnace experimented upon since has been so accurate. At each increment of 100lb. per square inch the furnace was gauged, so that under various pressures the limit of elasticity and the ultimate strength to resist collapse should be ascertained. Up to 500lb. per square inch no alteration in the cylindrical form of the furnace was perceptible; at 800lb. it had altered its

form to the extent of 1/16in., but on the pressure being released it entirely recovered its original shape. Permanent set could be distinctly measured at 850lb., and at a pressure of 900 it slowly collapsed, altering its form more readily than could be followed up by the pump. After collapse twelve holes were drilled in the furnace, and the thickness was found to vary from 0·51 to 0·53 of an inch.

It should be noted that until recently the Board of Trade took the mean diameter—viz., the mean between the least internal and greatest external. Lloyd's, however, take the greatest external, but for comparison of results given in this paper the diameter taken for the strength coefficient will be the mean diameter for furnaces of the Fox, Morison, and Farnley types, and the least external diameter for the Adamson, Holmes, and Purves designs.

The collapsing coefficient given by the test is:—

$$\frac{900 \times 35 \cdot 875}{52} = 62{,}091,$$

and the formula adopted by the Board of Trade for steel under 26 tons tensile, as a result of the experiment, was:—

$$\frac{12{,}500 \times \text{thickness in inches}}{\text{mean diameter in inches}}$$

= working pressure in lb. per square inch, and by Lloyd's for the same limit:—

$$\frac{1000\,(T-2)}{D}$$

= working pressure in lb. per square inch; where T = thickness of plate in sixteenths of an inch; D = greatest diameter of the furnace in inches.

The Board of Trade formula gives a working pressure of 181·2 for the above furnace, and Lloyd's a working pressure of 166·8, so that on a basis of 22·7 tensile the factor of safety by the Board of Trade rules was 4·97, and by Lloyd's 5·39. These factors are important, as they were the first granted for a modern furnace, and the experiment forms the basis of all subsequent tests, although now six furnaces are demanded for testing to destruction instead of one, and the severity of the requirements and the exactness of the tests are apparently increasing with each series. A higher value was granted by the Board of Trade than by Lloyd's for this furnace; but that the former was a perfectly safe allowance has been fully proved by experience, and will be referred to subsequently. From November, 1882, until 1890 the Fox furnace was made of steel between 21 and 25 tons tensile; but in the latter year it became necessary for commercial reasons to adopt a harder steel, with a view of obtaining a higher coefficient than that which had been in successful use during the last eight years. Accordingly, six furnaces were prepared and tested between the 4th November, 1890, and the 11th February, 1891.

Full particulars of these furnaces are given in Table II. The pitch and depth of the corrugations were the same as in the first test, the radical difference being that the steel employed had a mean tensile strength of 29·07 tons, as against 22·7 for the first test. The second furnace of this series is said to have collapsed at the 6in. plain part, where the thickness was only 0·331 of an inch, the mean thickness being 0·376. For this reason it has been proposed to abandon this test and take a mean of the other five; but as these furnaces were presumably made for purposes of experiment, at least as much care would be exercised in their manufacture as in those intended for sale, and therefore little injustice would be done by including this test with the others. Of the six furnaces tested, four collapsed on the plain part at the ends, one collapsed on the end corrugation, and the other on the second corrugation.

The mean collapsing coefficient from the six tests is 80,931, the difference between 62,091 and 80,931 being principally due to the increased strength of the steel, as may be seen by simple proportion:—

$$\frac{62{,}091 \times 29 \cdot 07}{22 \cdot 7} = 79{,}514\,;$$

and when it is remembered that these flues were made with a degree of accuracy resulting from an experience of eight years, and allowing a margin for the imperfections of the 1882 test, it is evident that the strength of corrugated furnaces under cold-water pressure varies directly as the tensile strength of the steel from which they are made.

Five tests of the Farnley flue were made under the Board of Trade in May, 1888, the results of which are given in Table III. The record of these tests is not quite so complete as many of the others. The steel being, it is understood, of ordinary boiler quality, is assumed to have had a tensile strength of 28 tons per square inch, and the mean collapsing coefficient when reduced to 27 tons has a value of 55,122, which is lower than that obtained with Adamson's rings. It should, however, be noted that the Farnley Iron Company have now improved their method of manufacture, and can make furnaces much more truly round, and therefore much stronger than when these experiments were made. A perspective view of the Farnley furnace is given in Fig. 6.

Table IV. gives the test results of the Holmes design (Figs. 7 and 8). Two of these flues collapsed at the plain part between two corrugations, and in the other case a corrugation and the adjacent plain part collapsed. The mean collapsing coefficient given by the three tests is 60,995, and the mean tensile of the steel was 27·2 tons per square inch.

TABLE I.—FURNACES MADE WITH ADAMSON JOINTS.

TESTS MADE AT THE WORKS OF MESSRS. HALL, RUSSELL AND CO., ABERDEEN, IN 1882, AND MESSRS. J. HOWDEN AND CO., GLASGOW, IN 1887.

The collapsing coefficients are calculated on the external diameter of the furnaces over plain part.

Date of Test.	Length of Furnace.	No. of Rings.	Thickness of Plate in Inches. Front End.	Middle	Back End.	Mean.	External Diameter in Inches over Plain Part.	Greatest Difference in Diameter at any part.	Collapsing Pressure.	Collapsing Co-efficient $\frac{P \times D}{T}$.	Ultimate Tensile Strength of Steel.	Collapsing Coefficients reduced to Steel of 27 Tons Tensile.	Position of Collapse.
1882	6ft. 5¾in. total; length of rings, 18¼, 19, 19, and 20in.	4	—	—	—	1st ring, ½" 2nd „ 15/32" F. 3rd „ 15/32" 4th „ ½" B.	43	9/64	3rd ring collapsed at 700	64,213	*	61,918	—
1887	7ft. 0½in. total; length of each ring, 23in.	4	—	—	—	0·546	43·09	No record	1st ring, 840 2nd „ 760 3rd „ 840 4th „ 815 Mean „ 814	64,240	*	61,945	—

* No record; probably 26 to 30 tons; assumed to be 28 tons.

TABLE II.—FOX'S PATENT CORRUGATED FURNACE.

OFFICIAL TESTS MADE AT THE LEEDS FORGE, LEEDS, IN 1882, 1890, AND 1891.

The collapsing coefficients are calculated on the mean diameter of the furnaces.

Date of Test.	Length of Furnace. ft. in.	No. of Corrugations.	Greatest Length of Flat at End.	Thickness of Plate in Inches. Front End.	Middle	Back End.	Mean.	Mean Diameter in Inches.	Greatest Difference in Diameter at any part.	Collapsing Pressure.	Collapsing Co-efficient $\frac{P \times D}{T}$.	Ultimate Tensile Strength of Steel.	Collapsing Coefficients reduced to Steel of 27 Tons Tensile.	Position of Collapse.
Nov. 1882	6 9	13	—	—	—	—	0·52	35·875	—	900	62,091	22·7	73,852	—
Nov. 4, 1890 and Feb. 11, 1891	6 3 5/16	11	5¾	0·339	0·361	0·331	0·349	34·125	9/32	830	81,157	29·05	75,430	On flat.
„ „	6 3⅞	11	6	0·345	0·384	0·398	0·378	34·25	5/32	800	72,436	29·17	67,094	On flat.*
„ „	6 7	12	6	0·419	0·463	0·462	0·452	33·625	4/32	1130	84,062	29·26	77,569	2nd corrugation
„ „	6 8 1/16	12	6 9/16	0·471	0·473	0·454	0·468	34·469	4/32	1090	80,280	29·02	74,692	On flat.*
„ „	6 5¼	11	6 5/16	0·577	0·585	0·551	0·574	33·593	7/32	1400	81,934	28·55	77,485	11th corrugati'n
„ „	6 6 1/16	11	5¼	0·542	0·582	0·596	0·575	34·937	8/32	1410	85,671	29·41	78,650	Front cor'g'ti'n*

* These three furnaces were annealed.

TABLE III.—FARNLEY SPIRALLY CORRUGATED FURNACES.

OFFICIAL TESTS MADE AT THE WORKS OF THE FARNLEY IRON COMPANY LIMITED, FARNLEY, NEAR LEEDS.

The collapsing coefficients are calculated on the mean diameter of the furnaces.

Date of Test.	Length of Furnace. ft. in.	No. of Corrugations.	Greatest Length of Flat at End.	Thickness of Plate in Inches. Front End.	Middle	Back End.	Mean.	Mean Diameter in Inches.	Greatest Difference in Diameter at any part.	Collapsing Pressure.	Collapsing Co-efficient $\frac{P \times D}{D}$.	Ultimate Tensile Strength of Steel.	Collapsing Coefficients reduced to Steel of 27 Tons Tensile.	Position of Collapse.
May, 1888	6 5¾	—	—	—	—	—	0·559	39·231	—	835	58,601	Assumed 28	56,508	No record.
„ „	6 6½	—	—	—	—	—	0·518	39·132	—	850	60,697	28	58,529	—
„ „	6 6¾	—	—	—	—	—	0·442	38·928	—	670	59,008	28	56,900	—
„ „	*6 6⅜	—	—	—	—	—	0·446	39·394	—	570	50,346	28	48,548	—
„ „	6 6 5/16	—	—	—	—	—	0·354	39·296	—	515	57,168	28	55,126	—

* This furnace was not so true as the others.

TABLE IV.—HOLMES'S CORRUGATED FURNACES.

OFFICIAL TESTS MADE AT THE WORKS OF MESSRS. CHARLES D. HOLMES AND CO., HULL, IN 1891.

The collapsing coefficients are calculated on the diameters of the furnaces over flats.

Date of Test.	Length of Furnace. ft. in.	No. of Corrugations.	Greatest Length of Flat at End.	Mean Thickness of Plate. Plain Part.	In Corrugation.	Diameter Outside of Plain Part.	Greatest Difference in Diameter at any part.	Collapsing Pressure.	Collapsing Co-efficient $\frac{P \times D}{T}$.	Ultimate Tensile Strength of Steel.	Collapsing Coefficients reduced to Steel of 27 Tons Tensile.	Position of Collapse.
1891	7 0	4	No record.	0·515	0·453	35·37	4/32	950	65,245	27·3	64,528	One corrugation and two adjacent plain parts.
„	7 0	4	„	0·452	0·424	35·62	10/32	750	59,104	27·5	58,029	Plain part between two corrugations.
„	7 0	4	„	0·557	—	35·5	6/32	920	58,635	26·8	59,072	Plain part and two adjacent corrugations.

(To be continued.)

Newcastle-on-Tyne Engineering Students' Club.

A MEETING of the above club was held in the Durham College of Science, Newcastle, on Wednesday, February 15, when Mr. J. Bowden read a most able paper on "Railway Brakes." Mr. A. Clement Hovey occupied the chair.

The author, after a brief review and explanation of the disadvantages of the older methods of braking trains, proceeded immediately with a most explicit description of the Westinghouse and automatic vacuum brakes of the present day, also the quick-acting arrangements of the same. The design and working of all details were fully explained and rendered exceptionally clear by means of numerous diagrams and slides.

Owing to the lateness of the hour when the lecturer terminated, the chairman intimated that the usual discussion would be necessarily postponed to a date of which the members would be duly advised. A hearty vote of thanks was accorded to the author.

Mr. Bowden expressed his indebtedness to the manufacturers of the brakes for the facilities they had afforded him in laying before the members of the club with such definiteness the intricate details of their respective brakes. A vote of thanks to the chairman terminated the proceedings.

Shipbuilding Notes.

Messrs. Brownells and Co., of Liverpool have contracted with Messrs. Alex. Stephen and Sons, Dundee, to build a steel sailing ship of 1300 tons register.

Messrs. Johnston, Sproule and Co., Liverpool, have contracted with Messrs. R. and J. Evans and Co., shipbuilders, Liverpool, for a steel four-masted sailing ship of about 2300 tons.

Messrs. Russell and Co., Port-Glasgow, have contracted to build a large four-masted sailing ship for Messrs. J. R. Dickson and Co., Glasgow. They have also contracted to build a steel sailing ship of 2700 tons carrying capacity, for Mr. Duncan M'Gilivray, ship-owner, Greenock.

The Union Steamship Company's new steel twin-screw steamer "Gaul" was launched on the 16th inst. from Messrs. Harland and Wolff's yard, at Belfast. The gross tonnage of the "Gaul" will be about 4830 tons, and she will be propelled by manganese-bronze twin-screws, driven by two sets of triple-expansion engines developing an indicated horse-power of about 2000.

On the 16th inst., Messrs. Irvine and Co., of West Hartlepool, launched a steel screw steamer of about 4700 tons deadweight carrying capacity, built to the order of Messrs. Thomas Appleby and Co., West Hartlepool. Her dimensions are 322ft. by 41ft. 6in. by 24ft. Engines of the triple-expansion type are being supplied by Messrs. Blair and Co. Limited, Stockton.

The steamer "Cuidad de Reus," launched by the Grangemouth Dockyard Company, recently went down the Firth of Forth on her official trial trip, when the speed obtained was two knots in excess of the guarantee. The dimensions are:—260ft. by 36ft. by 25ft. 6in. moulded; gross tonnage, 1900 tons; net, 1210 tons. The engines are of the triple-expansion type, having cylinders 20in., 33in. and 54in. in diameter by 36in. stroke.

The Selection and Treatment of Steel for Forgings.

(Concluded from page 54.)

THERE is another method of making forgings, which has budded and faded more than once, and that is the use of piled scrap steel, which is faggoted into blooms, reheated and swaged. The process was first applied at Dumbarton, later by the Mersey Forge, who rolled down ingots into flat slabs, and piled and welded them for cranks and other important work.

Railway companies also use this plan for side rods, draw bars, etc.; the resulting forgings ring under a stroke of a hand-hammer, the same as steel, but a fracture looks like iron. I do not approve the use of this process generally—believing that the forgings would be affected by extreme frost, and be in consequence dangerous, especially for draw-bar hooks, on account of the sharp snatches they have to endure. I think it best to pass the steel plate scrap through the Siemens furnace and use new ingots.

In connection with this subject, I will allude to the importance of the drop-stamp for producing small forgings in large quantities. The saving over hand-made articles is remarkable, but not more remarkable than the greater excellence of the product. The principal factor in this process is the dies, which must be made of very good material, and with exact workmanship. The next point to observe is the selection of a good soft material, which will bear forcing into the desired form, without breaking up. A most important feature is to make sure that the guides are true, or the trimming after the stamping will be very troublesome.

It sometimes happens in the manufacture of important steel forgings, that in spite of great care, internal defects still exist in the interior of the piece. This perhaps is never seen until the turner cuts into it, as is sometimes the case with a crankshaft; and when this occurs someone must lose money—generally the forgemaster; frequently the customer suffers with him, but never cheerfully—unless he feels he has avoided a disaster. These defects are generally to be traced to the existence of gas or air bubbles in the ingot, which hammering and rolling do not remove, but usually aggravate, by driving the occluded gas in various directions. Now this subject has occupied the minds of several good metallurgists, but the remedy is, in the main, as far off as ever. Whitworth employed the hydraulic pressure on the fluid steel as a remedy, but it is extremely expensive in practice and has not been generally followed.

A further branch of the business of forging is that known as bending prepared bars of forged steel or iron into bent cranks by using the hydraulic press. It means a great saving of time and labour, and when numbers of a given type and size are called for, and a powerful steam stamp associated with the press, cranks of the best shape and finish can be produced at very low prices, the principal outlet being in the direction of portable and kindred engines and for gas engines. This process was first employed only for the manufacture of cranks having a round section, but since 1884 the firm of which I am a member have turned their attention to making bent cranks having the same configuration as forged slab cranks, at the same time providing for the fibre of the material to be continuous throughout the piece, and also avoiding the delay and labour inseparable from the drilling and slotting of slab cranks.

This process is now in daily operation for locomotive and electric-lighting engines, and also for marine and mill engines, and is giving great satisfaction. In conclusion, having mentioned locomotive cranks and their production by the bending process, it may be said that wonderful mileage has been got out of locomotive axles by the older method; indeed, recent cases have come under my observation showing 750,000 miles run, but it is very frequently the case that new axles fail in their first year, and in many cases the causes are due to want of work on the vital parts. Numerous "cripples" recently examined showed fractures on the underside of the crankpin, the next in order showed weakness on the inside web, and others failed from the strain of twisting by wrenching the webs from a straight line to right angles at the forge. I ought to speak cautiously at Leeds on this subject; but I am convinced that the present practice of loco. crank-axle making is wasteful, clumsy, and expensive, giving the worst results on the maximum expense.

Intimately connected with steel forgings is the practice of tempering in oil, in order to increase the toughness of the article so treated. Locomotive axles are often oil tempered, as are the inner tubes and trunions of large guns, while smaller guns are heated entire and quenched vertically in a bath of oil, the oil vat being itself immersed in cold water, sometimes artificially cooled, so as to keep the oil at proper temperature. Steel, which in its normal state will bear a maximum load of 31 tons, will, after heating and quenching in oil, carry 43 tons tensile stress, and gun-barrels after such treatment are reheated sufficiently to reduce the tensile stress to 37 tons, which gives excellent practical results. In this state the metal works very sweetly. I recently saw a turning 268ft. long, taken from an oil-tempered steel gun-barrel. Where high results are desired, and price is no object, the oil tempering is a very good thing, but, like other good things, it costs money.

Another subject in connection with forgings is that of the proper allowance for tooling. This is a question on which all experts differ, and can best be solved by the application of a little common sense. Engineers will ask for 3-16ths on a double crank, and others will allow ½in. on a plain bar of similar size; both are wrong. A very good rule for articles having but one setting is to allow ¼in. up to 5in. diameter, ⅜in. for 6in., 7in. and 8in., ½in. for 10in., and 1in. for 1ft. Most turners will agree that an allowance sufficient to clean up the forging all over is more easily dealt with than a closely-forged shaft, which has to be humoured in the lathe, and requiring its centres altering several times. Given a good lathe, a good man, and a straight forging, no one need complain if an extra eighth has been left on by the forgeman.

Next to the smith, the engineer of to-day has a most useful ally in the forgeman, and I sincerely trust that all three, with the aid of the founder, will, in the future, as in the past, uphold the reputation of Old England for mechanical engineering the world over.

The paper was followed by a discussion, in which Mr. Lupton said that in making forgings carefully, with proper allowances for turning, no time was wasted or labour lost, inasmuch as it was saved in the lathe.

Mr. Drake depreciated the chemical tests frequently specified where the steel was required for purely mechanical purposes, as being useless, and sometimes mischievous.

Mr. Atkinson said that there should be a limit to the amount of testing required, and was of opinion that much needless expense was incurred in that direction.

Mr. Holgate said that the variation in steel was so great both in quality and temper, and the purposes to which it is applied were so various, that for any works to set up any particular steel of any particular temper, was to confine itself to very narrow ground.

Mr. Wood said that the forms of steel which Mr. Rixson had used as specimens should all be tested mechanically, but in the case of boiler plates the chemical test was necessary. He was of opinion that in the manufacture of steel, if good stuff was put in, it was probable that good stuff would be the result.

Messrs. Towler and Blackburn also spoke, and Mr. Rixson having replied, a vote of thanks to the latter gentleman, proposed by Mr. Tempest and seconded by Mr. Blackburn, was carried unanimously.

Mason College Engineering Society.

A GENERAL MEETING of the above society was held in Mason College, Birmingham, on Wednesday, February 15, when a paper on "The Birmingham Hydraulic Supply Station" was read by Mr. Henry Lea, M.I. Mech. E.

After a brief sketch of the history of modern water-pressure machinery, the author proceeded to describe the Birmingham Corporation Supply Station, which was engineered by Mr. J. W. Gray and Messrs. Henry Lea and Thornbery in conjunction. The station was opened in 1891. The motive power is derived from one 12H.P. and two 20H.P. Crossley gas engines, working hydraulic machinery erected by the Chester Hydraulic Engineering Company. After entering into the details of the gas engines, the special arrangements relating to the exhaust pipes, the cooling of the water jackets by water which is on its way to the pumps, the starting of the engines by hydraulic motors, the hydraulic pumps and accumulators, and the manner in which they are made interdependent, Mr. Lea proceeded to describe an arrangement of counters from which interesting figures were obtained, showing that although there is necessarily at present much idle running, during which the machinery is not actually pumping into the accumulators, the efficiency of the plant is very high, the pumps delivering energy equal to about 60 per cent. of the indicated horse-power of the engines. When pumping continuously the efficiency is as high as 81 per cent.

In the use of the high-pressure water for lifting purposes, the cost per ton lifted varies with the quantity of water used per quarter of a year, a sliding scale of charges being adopted; thus about 12cwt., or 8 persons, can be raised 40ft. for 1d. when the minimum quantity per quarter is used, and about 3 tons, or, say, 40 persons, to the same height when the maximum quantity is used.

The paper was illustrated by limelight views and models, several of the latter being lent by the Chester Hydraulic Engineering Company, and being explained by Mr. Carter, the managing director of the company.

A discussion followed the paper, Mr. J. W. Gray, C.E.; Prof. Smith, Mr. R. J. Richardson, Mr. Watkins, Mr. Pinkney, and other gentlemen taking part, the proceedings terminating with a vote of thanks to Mr. Lea for his paper.

Wrought Iron.

THE fourth popular lecture on "Wrought Iron" was delivered on the 16th inst., at Mason College, Birmingham, by Mr. T. Turner. After describing sundry details of furnace construction, and the difficulties that are met with in endeavouring to determine the best form of furnace, the lecturer described in detail the nature of the changes that take place during the purification of cast iron in puddling. It was first mentioned by Price and Nicholson, in a patent granted in 1856, that when cast iron was subjected to oxidising influences the silicon was almost entirely removed before the other impurities were to any considerable extent affected. Shortly afterwards, in 1858, Calvert and Johnson, in their well-known researches, determined some of the most important facts with regard to the removal of several of the other impurities. But though the sequence of the changes was thus made out, the theoretical reason underlying the changes was open to discussion for many years, and in some particulars is even yet unsettled. Arguing from analogy with what takes place in steel-making, it was suggested that the purest iron would give the largest yield and the best product, and that the changes were the result of the action of ferric oxide on the carbon and and other impurities that were removed. The late Sir W. Siemens, in 1868, was the first to point out that the most active agent in the puddling furnace was the fluid magnetic oxide, which, owing to its fluid condition, can readily act on the molten iron and bring about the required changes. Too much ferric oxide leads to a thick slag, which is less active in its character, which is not so good to work, and which leads to waste of metal by atmospheric action. But when the slag is of proper composition it both purifies the iron and "nourishes" it as well; that is, the slag supplies oxygen to remove the impurities, while in so doing the oxide is itself converted into metallic iron and added to the charge. It is therefore a mistake to regard the fluid slag as useless or harmful, and sufficient hammer slag or other cheap fusible fettling should be charged early in the process, so as to give what is required. A pig iron with too much silicon or phosphorus gives bad results owing to excessive requirement of fettling, or what the puddler aptly calls its "hungry" character; but, on the other hand, if the metal used is too pure, not only is the yield less, but the product is often red, short, and inferior. An iron of intermediate quality is thus most suited for the use of the puddler, and in this fact lies one of the most important reasons which have led to the continuance of puddling in the face of such formidable rivals. By means of a very interesting series of lantern slides, prepared from photographs of the interior of the furnace during the progress of a charge, the nature of the changes that take place was rendered clear, and the audience was thus able to follow each step of the process from the preparation of the furnace after a previous charge to the rolling of the finished bloom of iron into a puddled bar.

THE directors of Brown Bayley's Steelworks Limited, Sheffield, recommend the payment of a dividend of 20 per cent. on the past year's working. The report shows a net profit of £29,421. It states that for the past few months there has been a considerable scarcity of orders, and there is at the present time much difficulty in securing work at remunerative prices.

Notices of New Books.

WORKSHOP RECEIPTS (Fifth Series). London: E. and F. N. Spon.

THE well-known series of handbooks published by Messrs. Spon under the above title have enjoyed a considerable reputation with the industrious amateur for nearly a quarter of a century, while as a work of reference for skilled workmen, mechanics, and others it has also acquired well-merited distinction. In adding a fifth volume the range of subjects has been widened, while the information contained in the earlier volumes has been brought up to date. Among the many subjects treated on in the present volume we notice cements, distilling, explosives, lacquers, metal work, pumps, stereotyping, barometers, waterproofing, etc. The information given appears to be of the same reliable character as that contained in the earlier issues, while a large number of illustrations are included.

THE GRAMMAR OF WOODWORK. By WALTER E. DEGERDON. London: Macmillan and Co. 2s.

MR. DEGERDON, who has been for some time the head instructor of the woodwork department of the Whitechapel Craft School, has in this work given a series of lessons in manual instruction which teachers of this branch of handicraft will find very acceptable. The work is divided into 21 lessons, progressively arranged, and is certainly calculated to give the attentive student a thorough insight into the rudiments of the art of working in wood.

Trade Notes.

The Phosphor Bronze Company recommend a dividend of 1½ per cent.

The Edwards Shipbuilding Company, Newcastle-on-Tyne, have ordered two powerful centrifugal pumping engines and two duplex pumps from Messrs. Tangye, Birmingham.

The dividend recommended by Messrs. Perry and Co. Limited, of Birmingham, on the ordinary shares, 12½ per cent. for the year and 2½ per cent. bonus, is the same as last year.

The Glasgow Water Commissioners have accepted the offer of Messrs. P. and R. Fleming and Co. for the ironwork of the Lech Chon section of the new Loch Katrine aqueduct.

The Carbon Steel Company, Pittsburg, Pa., has contracted with the United States Government for the supply of over 10,000 tons of plates for the new warships "Brooklyn" and "Iowa."

Messrs. De Bergue and Co., and Mr. Edward Wood, Ocean Ironworks, both of Manchester, have received orders from the Ship Canal Company to erect two large iron sheds for warehousing goods.

The contract for the station-to-station electric-bell signals and the electric-bell communications in the cars of the new overhead railway at Liverpool was placed with Messrs. Maunsell Mercier and Co., of Manchester.

Messrs. Easton and Anderson Limited, of London and Erith, have contracted for the sum of £9381 to supply and erect engines, pumps, boilers, mains, and apparatus in connection with the new municipal waterworks at Colchester.

Messrs. Siemens Brothers and Co. Limited, London, have contracted with the Bristol Corporation for the supply of mains, arc lamps, underground feeders, etc., required for the electric lighting scheme. The amount of the contract is £16,658 10s.

Messrs. Hugh Smith and Co., Possil Park, Glasgow, have constructed a patent shearing machine for the Fairfield Shipbuilding and Engineering Company. The machine is intended for shearing the ends of channel bars of the largest section now used for ship frames.

The Saxon State Railway authorities have decided upon the erection of a large central station for the electric lighting of the railway station and buildings at Dresden. The contract is in the hands of Messrs. Siemens and Halske, Berlin, and the Helios Company, of Ehrenfeld, Cologne.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 391, Strand, London, or New Bridge-street, Manchester.

Having regard to the enormous circulation of THE MECHANICAL WORLD, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if MECHANICAL WORLD readers will kindly bear this in mind as occasion arises.

Hydraulic Machinery.—XIII.

FIG. 37 shows an arrangement of a direct-acting sluice machine, as used for the sluices in docks. It consists of a piston and ram working in a cylinder, bored the full length and with inlet at top and bottom for the admission or exhaustion of the water. It is so arranged that when lifting the sluice the water is admitted to the underside and the full area is available. To close the sluice the water is admitted into the annular space at the top, the weight of parts acting in favour of the closing and allowing a less area to be used. As these sluices are worked every time the gates are opened, it is usual to provide some means of working them by hand. Fig. 38 shows a hand pump used for this purpose, which will need no explanation. It is worked by eight men, and they can open the sluices in about two minutes. The pistons of the sluice cylinder are packed with two L-leathers placed back to back, as shown in section Fig. 39. These L-leathers often chafe through at the bend, and to obviate this Messrs. Angus and Co., of Newcastle, have introduced a double L-leather, as shown in Fig. 40 which adds additional strength and wear exactly where it is required.

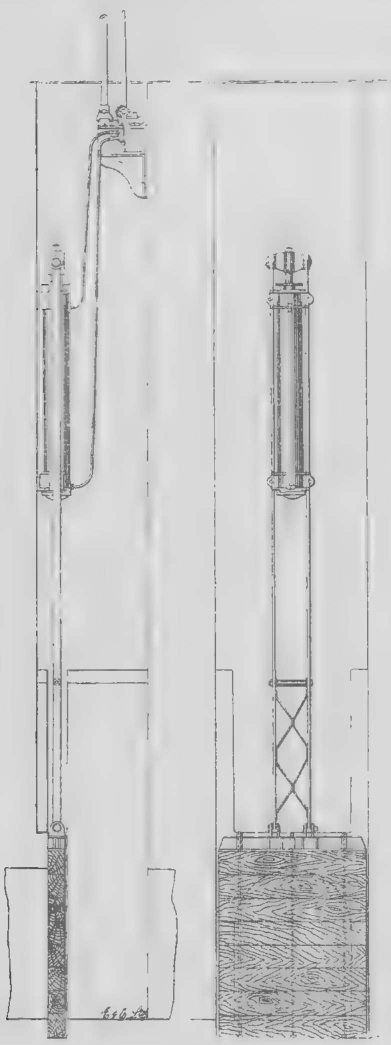
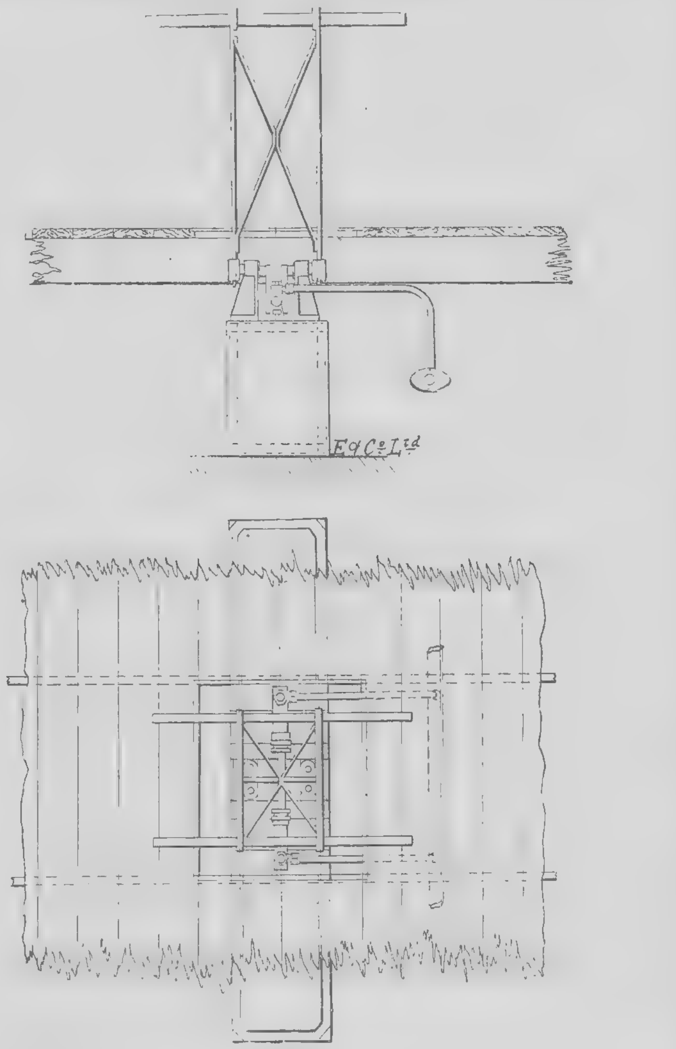


FIG. 37.



HYDRAULIC MACHINERY. FIG. 38.

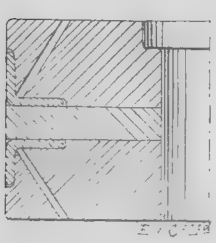


FIG. 39.

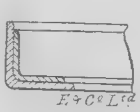


FIG. 40.

To find the pressure required to open a sluice, let A = area of the sluice in feet, B = the depth of the centre of gravity of the sluice from the surface in feet, C = coefficient of friction depending on the surfaces in contact—cast iron on cast iron or brass, 0·25; for wood, such as greenheart, on granite, 0·3. Then, pressure on rods to open the sluice = A B C × 64. The diameter of the cylinder can then be found in the same manner as for a hydraulic hoist or crane.

(*To be continued.*)

MESSRS. C. A. PARSONS AND CO., of Newcastle-on-Tyne, are fitting 500 incandescent lamps in the mill of Messrs. Kelsall and Kemp, of Rochdale.

On Apparatus for Determining the Amount of Water Suspended in Steam.*

THE object of this short paper is to raise a discussion on the different methods adopted at engine and boiler trials for measuring the amount of water suspended in the steam supplied to the engine. In the first place, the writer considers it almost unnecessary to point out the enormous value of engine and boiler trials, such as those carried out during the past few years by the Institute of Mechanical Engineers.

Trials of this kind, if properly carried out, have a use quite apart from their scientific interest, as they enable the engineer to see the weak points in the system under trial, point out in what manner it is better than that which it has superseded, and, most important of all, indicate the direction in which further improvement may be made.

To obtain a real comparison between different types of engine and boiler, it is very necessary to separate the different efficiencies which go to make up the total efficiency of any combination. The efficiency of a boiler is made up of the efficiency of the furnace and the efficiency of the heating surface. The efficiency of an engine is made up of the efficiency of the steam and the efficiency of the mechanism. The measurements usually made at trials of marine machinery are: Weight of coal burnt, analysis and calorific value of coal, analysis and temperature of funnel gases, indicated horse-power, weight of water pumped into the boiler, and amount of "priming" water delivered to the engines. In the opinion of the writer this last measurement is of the greatest importance, as, without it, it is impossible to separate the efficiency of the engine from that of the boiler, and, moreover, all calculations as to the condensation and re-evaporation in the cylinders, effect of jackets, etc., can only be based on guess-work.

A notable instance of how priming may vitiate trial results occurred at the Mechanical Institute's trial of the s.s. "Tartar." No means were taken at this trial for measuring the amount of priming, the steam being assumed to be practically dry. On making the calculations after the trial it was found that the efficiency of the boilers was unexpectedly high, and that of the engines unexpectedly low (on the assumption that all the water pumped into the boilers was turned into steam). A very complete analysis of the waste gases, however, had been made, which enabled the Research Committee to state that a considerable amount of priming had taken place, probably amounting to about 20 per cent. of the total feed.

In this instance the amount of water present in the high-pressure cylinder amounted to no less than 55 per cent. of the total steam and water passing through it; and on referring to the reports of the other trials it will be seen that the amount of water present at various stages often reaches 40 or 50 per cent., and this water is all, or nearly all, suspended in the steam in a very fine state of division, as is seen when the indicator cock is opened and the mixture of steam and water allowed to blow through it.

The lessons taught by this trial are: (1) that it is impossible to gauge the wetness of steam by its apparent condition at the indicator cock, and (2) that the ordinary marine boiler may under no apparent provocation deliver steam containing 20 per cent. of water. May this last fact not also throw some light on the otherwise inexplicable anomalies as set forth in the recently-published report of the Research Committee on the "Efficiency of Steam Jackets"?

Before proceeding to describe the various apparati, it might be well to make some inquiry into the nature of priming. Priming may be due to two actions, the first of which may be described as being entirely mechanical—that is to say, the particles of water projected into the steam space of a boiler by the ascending bubbles of steam become wholly or in part suspended in the steam. The second cause is due to insufficient absorption of heat, which latter may be due to two causes. Take the case of an isolated drop of water at the same temperature as the steam. This drop may receive enough heat to turn the whole of it into steam, and may take up a certain quantity of water before it reaches the steam space, or it may reach the steam space without having received sufficient heat to turn the whole of it into steam.

It does not seem possible to estimate how much each of these causes affects the total amount of priming, but it seems probable that the second cause should depend upon the disposition of the heating and water surfaces and the temperature of the gases, and that the erratic nature of priming is due to the first-mentioned cause.

The presence of grease in a boiler often causes priming. Can it be that greasy steam is capable of holding more water than clean steam? Perhaps particles of grease in the steam space act as nuclei round which water will collect.

Among the first attempts to measure the water contained in steam was that by means of an apparatus called the "barrel" calorimeter.

It consists of a vessel (probably originally a barrel, hence the name) containing a known weight of water at an observed temperature. The steam to be tested is led to the bottom of the vessel, thus passing through the water and becoming condensed. At the end of the test the increases of weight and of temperature are noted, and from these data and a table of the properties of steam the amount of water in the steam may be calculated.

This apparatus has many disadvantages. In the first place, a correction must be made for radiation from the apparatus and for the amount of heat absorbed by it; and, in the second place, a correction must be made for any evaporation which may take place from the surface of the water.

Although this latter may be neglected if the final temperature be kept sufficiently low, the corrections for radiation and absorption present a good many difficulties, entailing tests on the apparatus to determine the loss of heat under varying conditions, such as different temperatures of atmosphere and different durations of test.

The greatest disadvantage of this apparatus, however, for use on board ship would be the difficulty of weighing with sufficient accuracy.

The next method to be considered is that of the salt test, which is carried out as follows:—A sample of water is taken from the boiler, and the percentage of salt held in solution is determined with great accuracy. A sample of steam from the steam pipe is at the same time collected in a small special condenser, and the percentage of salt in it is determined by chemical analysis, as in the case of the water from the boiler. From these data the amount of priming water may be calculated.

This method should give accurate results for what the writer has called "mechanical" priming, provided the sample of water were taken from the right place—viz., near the water surface,—but it is not at all certain that it would give reliable information as regards the other kind of priming; in short, the truth of the result of the calculations depends upon the assumption that the whole of the salt in solution is precipitated at the moment the water assumes the gaseous form.

Take the case of an isolated drop of water at the temperature of evaporation, and suppose it to contain 5 per cent. of salt in solution. Let it receive enough heat to turn three-fourths of it into steam, then if at the moment of gasification the drop of water contained 5 per cent. of salt, the resultant steam would contain $5 \div 4 = 1\frac{1}{4}$ per cent. of salt. If, on the other hand, some of the salt were precipitated before the moment of gasification—suppose, for instance, that $2\frac{1}{2}$ per cent. were thus precipitated,—then it is evident that the steam would only contain $\frac{5}{8}$ per cent. of salt instead of $1\frac{1}{4}$ per cent. as before. The writer is not aware of any experiments on the behaviour of salt in a solution of water subjected to gradual heating and evaporation; but if the whole of the salt does not remain in solution until the moment of gasification, then the results will be inaccurate to an extent which cannot be easily estimated, as it depends upon two factors—first, the proportion of each kind of priming; and, secondly, the amount of precipitation before gasification. In this connection it will be well to note the length of time the water remains in the boiler. Take the case of the Mechanical Engineers' trial of the paddle steamer "Ville de Douvres." The boilers contained $61\frac{1}{4}$ tons of water = 137,760lb. Total feed per hour = 66,180lb. 137,760 ÷ 66,180 = 2 hours about.

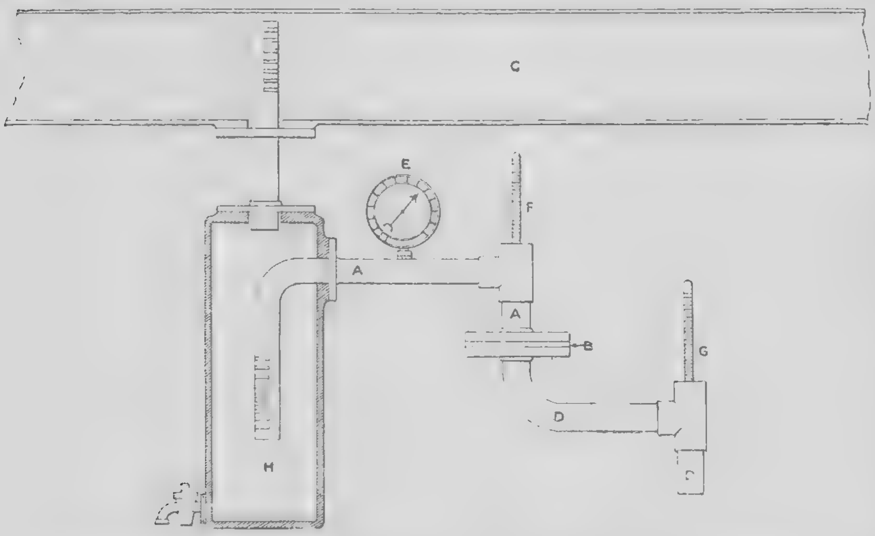
It is thus easy to imagine that at any moment there may be a certain portion of the water in the boiler—viz., that which is on the point of being turned into steam—containing a less percentage of salt than the body of water from which the sample is taken. Another source of error may be introduced when more than one boiler is supplying steam and only one condenser is used on the main steam pipe, for it is evident that if the boilers have different percentages of salt, and one boiler does more priming than the other, an error will be introduced. Hence, when more than one boiler is in use, a separate sample should be taken from each branch pipe. Taking these points into consideration, it appears to the writer that the salt test would not be sufficiently reliable for accurate results, the probability being that the amount of water in the steam would be under-estimated.

The next apparatus to be considered is the Barrus calorimeter. The action of

*Paper by Mr. W. R. Cummins, read before the North-east Coast Institution of Engineers and Shipbuilders.

this instrument is based on the fact that if steam be allowed to expand without doing external work, it will become superheated; that is to say, the heat which would be transformed into work if the steam were expanding and doing work on a piston, is expended internally — viz., by heating itself, or by evaporating any contained water.

The apparatus consists of a tube A (see Fig. 1) having its end closed by a diaphragm B, perforated with a small hole. The steam to be tested is led from the steam pipe C to the tube A, from whence



APPARATUS FOR DETERMINING WATER IN STEAM.—FIG. 1.

it escapes to the atmosphere through the small hole in the diaphragm by means of the tube D.

A pressure gauge E and thermometer F are inserted in the tube A, and a thermometer G in the tube D. Suppose the steam to be of 150lb. pressure: then if it were dry, saturated, and no heat were lost by radiation, the amount of heat available for superheating would be $1225 - 1178 = 47$ thermal units = difference of total heat of steam at 150lb. pressure, and steam at atmospheric pressure. Specific heat of superheated steam = 0·48. Hence amount of superheat $= \frac{47}{0.48} = 98°$ F. approximately. So that the thermometer in the tube D would indicate $212° + 98° = 310°$ F.

Next, suppose the steam to contain 5 per cent. of water, then total heat of steam and water at 150lb. pressure $= (0.95 \times 1225) + (0.05 \times 370) = 1182$ thermal units. Total heat at atmospheric pressure if all water be evaporated = 1178 thermal units. Difference = 4 thermal units, available for superheating. Amount of superheat $= \frac{4}{0.48} = 8°$ F. Hence thermometer in tube D would indicate $212 + 8 = 220°$ F.

It will be seen at once that this apparatus is very sensitive to small variations in the percentage of contained water. For example, with steam of 150lb. pressure there is a difference of 90° F. for 5 per cent. of water, but, on the other hand, it has only a limited range; for instance, with steam of 150lb. pressure the range is limited to about 5 per cent. of water, without taking account of radiation, as 6 per cent. of water reduces the heat available for superheating to a negative quantity, and at 80lb. pressure the range is practically limited to 3 per cent. of water.

An attempt has been made to get over this difficulty by fitting what is called a "drip box" H, as shown in Fig. 1, the function of which is to intercept as much as possible of the contained water.

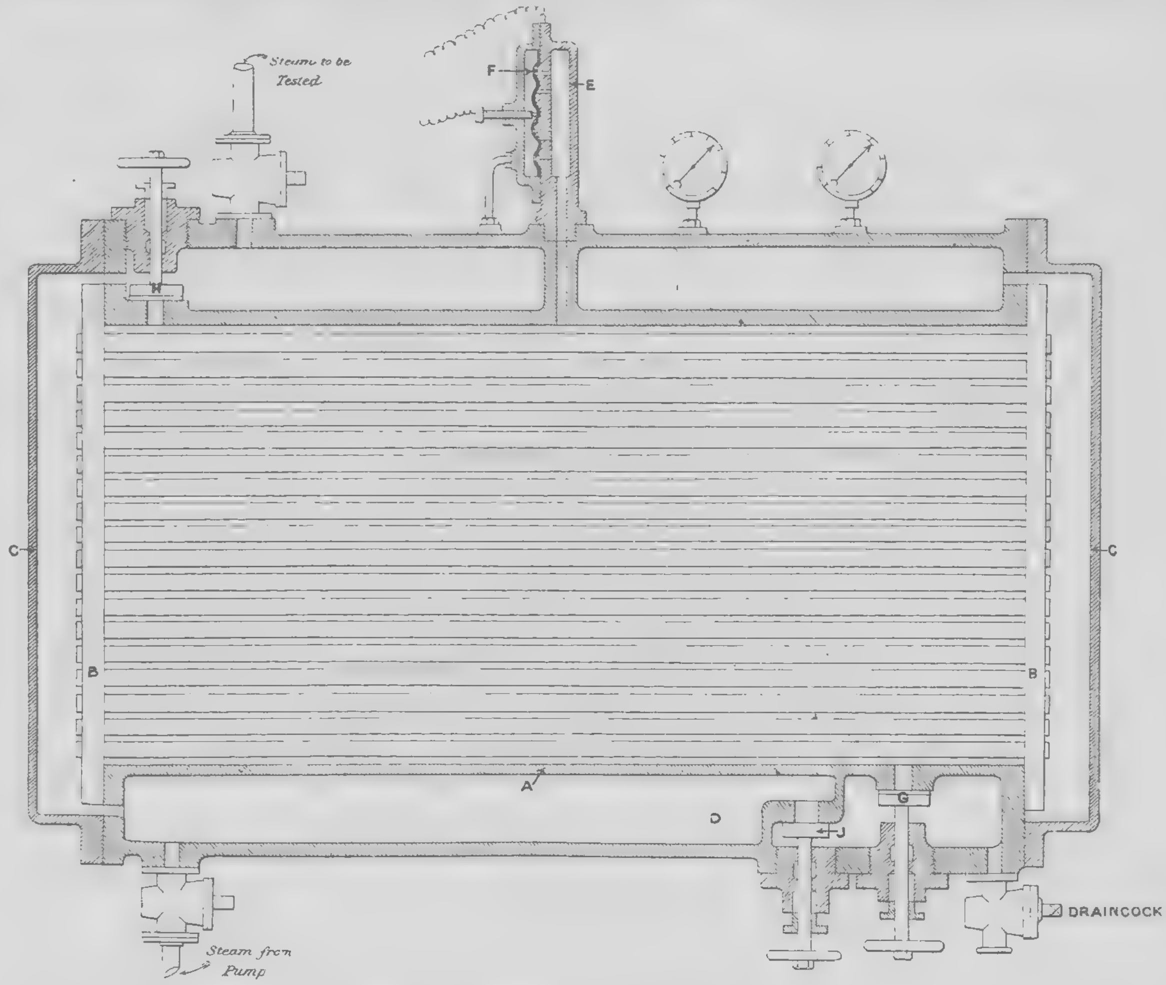
The water collected in this box is drawn off at intervals and weighed, and the proportion which this latter bears to the total quantity of steam passing through the instrument is added to that calculated from the amount of superheat.

The quantity of steam passing through the small hole is determined by experiment for each apparatus, the steam being led to a condenser, collected, and weighed. This seems to be a very rough-and-ready way of calculating what, in a great number of cases, will be the greater proportion of the contained water, unless very careful experiments are made to determine the weight discharged under every condition of steam pressure, atmospheric pressure, and wetness of steam. This defect, however, could be remedied by always using a condenser in connection with the apparatus, and the addition of an air-pump for maintaining a vacuum in the condenser would increase the range of the instrument; thus for steam of 150lb. pressure and a vacuum corresponding to 2lb. absolute pressure, the range would be increased from about 5 per cent. of water to about 8 per cent. of water. It seems probable that the drip box under certain conditions would not be able to intercept a sufficient proportion of the suspended water. In this case a centrifugal separator might be used to replace the drip box.

When using this apparatus a certain allowance must be made for radiation, and the difficulty of estimating this allowance will always leave some doubt as to the correctness of the results. There is a certain amount of heat available for evaporating the moisture and superheating the steam, and this is distributed between the steam and the material of the apparatus.

If the steam be of constant quality the apparatus will after a time arrive at a normal temperature, and the only heat not given to the steam will be equivalent to that lost by radiation to the atmosphere.

If, however, as will probably be the case, the percentage of water be continually varying, the thermometer in the tube D will not give correct readings, as it will be influenced by heat given out and taken up by the material of the apparatus; that is to say, the thermal capacity of the apparatus will tend to lessen the oscillations of



APPARATUS FOR DETERMINING WATER IN STEAM.—FIG. 2.

the thermometer G, and thus lead to erroneous results.

Taking the above points into consideration, it appears to the writer that the Barrus calorimeter should give fairly accurate results for high pressures and small percentages of water, but for low pressures or large percentages of water it would require considerable modification to make it generally useful.

In order to overcome the difficulties connected with the three methods described above, the writer has designed the apparatus shown in Fig. 2. It consists of a cylinder A filled with a number of small tubes fixed in the tube plates B. A jacket D is cast round the barrel, and the covers C form jackets for the ends.

The principle of the action of the apparatus is to evaporate the water contained in a sample of the steam under test, in a vessel of fixed volume. When all the water is evaporated the increase of pressure is noted, and a simple calculation gives the percentage of water originally in the steam.

The heat required for thus evaporating the water contained in the sample of steam is supplied by admitting to the jacket steam of higher temperature than that of the sample in the cylinder.

When the steam to be tested is of boiler pressure, and no higher pressure is available, a small steam ram pump may be used to pump steam of the required pressure into the jacket.

The point at which all the water in the sample is evaporated is determined by the fact that superheated steam has a lower pressure than saturated steam of the same temperature. Hence, so long as the pressure of steam in the cylinder and that in the jacket (which is kept saturated) is the same, it will be known that the sample steam is saturated; but as soon as the pressure in the cylinder falls below the pressure in the jacket, then it will be known that all the water has been evaporated and the sample will be superheated.

On top of the apparatus is an attachment E for detecting very small differences of pressure between the cylinder and the jacket. It consists of a thin diaphragm F of corrugated steel, one side of which is in connection with the sample steam in the cylinder, and the other side is in connection with the jacket.

Immediately the pressure in the cylinder falls below that in the jacket, the movement of the diaphragm breaks an electric circuit and cuts out a bell.

The operation of testing a sample of steam would be as follows:—First, the jacket and cylinder would be opened to the steam to be tested, so that the whole of the surfaces would be brought to the same temperature as it. The outlet valve G would then be opened and the inlet valve H closed, so that any water adhering to the surfaces would be evaporated, and enough steam blown through to ensure a fair sample of steam being in the cylinder. The outlet valve G would then be closed, and then the inlet valve H. The pressure in the jacket would then be gradually raised until the bell ceased ringing, which would indicate that all water had been evaporated.

As regards the probable accuracy of results obtained from this apparatus, the first point to be considered is the reliability of the data at our disposal on the density of saturated steam at different pressures.

This has not yet been experimentally determined, but can be calculated from the latent heat, pressure, and temperature, which latter have all been determined by Regnault.

The next question concerns the constancy of volume of the steam in the cylinder, as an error will be introduced if the volume is not constant throughout the test.

In the first place, the volume of the cylinder may vary owing to expansion by increase of temperature. This may be calculated and allowed for. Increase of pressure may cause a variation of volume due to distortion of the cylinder, but does not seem at all likely, as the cylinder will be practically under an equilibrium of pressure. There may also be a variation in the volume of the pressure-gauge tube, and the motion of the diaphragm will also cause a variation which may be calculated and allowances made.

The volume occupied by the suspended water will be so small that it may be neglected. The next question is: Will the temperature of the steam in the jacket and tubes be distributed throughout the mass of the sample steam in the cylinder? There should be no doubt of this if the tubes are put sufficiently close together, and if care be taken that all surfaces exposed to the steam being tested are properly jacketed.

Leakage would be rendered impossible by brazing all joints exposed to pressure from the steam in the cylinder. The inlet and outlet valves, H and G. to the cylinder might present some difficulties, and in order to minimise these it will be seen that they are both so arranged that during the time of testing (the valve J being then open and the drain cock shut) the tendency to leak, which should depend upon the difference of pressure on each side of the valve, will be practically nil.

Probably the greatest difficulty will be the correct determination of the time when all the water in the sample is evaporated, and this will depend upon the efficiency of the diaphragm F in indicating small differences of pressure. The diaphragm can, however, be tested beforehand by subjecting each side to pressure by means of a column of mercury, noting what difference of pressure is required to break the electric circuit.

An error may be introduced, by the presence of air or vapours other than steam, in the sample. In all probability, however, if air were present it would be in exceedingly minute quantity and not sufficient to materially affect the result.

The apparatus may be applied to the receivers of an engine as well as to the steam pipe, and also to the exhaust as it leaves the low-pressure cylinder, by which means our knowledge of what goes on in the cylinders would be vastly increased.

In conclusion, the writer wishes to again emphasise the value of exhaustive trials

on marine engines and boilers, so that some answer may be given to the following questions :—

Is the economy of the triple-expansion engine due to high pressure alone, or due to lessened initial condensation in the cylinders owing to a diminished range of temperature? If so, why do trials show that the initial condensation in the high-pressure cylinder of the triple-expansion engine is just as much and sometimes more than the condensation in the high-pressure cylinder of the compound engine?

Is there not reason to believe that the ordinary marine boiler supplies steam containing a hitherto unsuspected amount of water, thus accounting for the apparently large amount of condensation in the cylinder? Does the presence of water impair, *per se*, the efficiency of steam?

Is the amount of priming affected by the boiler pressure? Are steam jackets of any advantage to a marine engine, and if so, to which cylinder should they be applied?

Goldsmiths' Institute Engineering Society.

On Saturday, the 18th inst., the annual gathering of the above society was held in the building of the Institute, under the direct patronage of the governors and the vice-presidents, Messrs. W. J. Lineham, M.I.M.E., and J. S. Redmayne, B.A., being also present. Upon an intimation being given to several engineering firms that the above gathering was to take place, many of them at once took advantage of the opportunity of sending exhibits of their latest and special productions, which demand more than passing notice, such as the Gates Ironworks' Ingersoll duplex hand-power rock drill, an ingenious contrivance for facilitating rock excavations. The same firm's crushers, which are of recent invention, also created considerable interest, and the economy of labour in using them was at once apparent. The Crosby Steam Gage and Valve Company exhibited two of their indicators. The collection of tools by Messrs. Selig, Sonnenthal and Co., included their famous drills; also the "Stow" flexible shaft and the "Champion" pipe wrench. The National Telephone Company lent some forty telephones, which were fitted up by Mr. Hardstone and worked with admirable success, the concert in the Central Hall being transmitted some hundreds of yards and heard by all to their great satisfaction.

Mr. Lineham, the principal of the engineering section of the Institute, specially called the attention of students who are studying with a view of carrying on their profession in the colonies and South America to those exhibits likely to be of use to them in those fields of industry. On account of the success of the gathering, and the large number of visitors, it has been proposed that an exhibition of machinery should be held, to extend over a period of some days.

Electrical Railways.

At the ordinary meeting of the Institution of Civil Engineers, held on Tuesday, the 14th inst., Mr. Harrison Hayter, president, in the chair, a paper was read dealing with "Electrical Railways," by Dr. Edward Hopkinson, M.A., M. Inst. C.E.

After reference to the recent progress made in the United Kingdom in the application of electric traction to tramways, and a comparison of this with the work done on the Continent and in the United States, a brief account was given of the conditions which Messrs. Mather and Platt, of Manchester, were required to meet in their contract for the electrical plant of the City and South London Railway.

The leading features of the line were briefly alluded to. The maximum gradients were 1 in 14 with, and 1 in 30 against, the traffic. There were four intermediate stations between the City terminus and that at Stockwell, the trains running at intervals of from 3min. to 4min. The total length was 3 miles and 270yds.

Full details were given of the generator station. There were eight boilers of Lancashire type set on the Livet principle, with Vicars' automatic stokers, working at 140lb. pressure per sq. in. The generating plant consisted of four open vertical compound engines, and four "Edison-Hopkinson" dynamos. The latter were belt-driven, and had an electrical efficiency at full load of 96 per cent., and a commercial efficiency of 93·4 per cent., their weight being 17 tons. They were compound wound, and had a maximum output of 450 ampères at 500 volts, running at about 500 revolutions per minute. In connection with the driving of the generating dynamos, the theory of jockey-pulleys on high-speed belts was incidentally considered.

The feeding conductors employed were of the Fowler-Waring type, the working conductor being of channel steel, laid between the rails and carried on glass insulators fixed to the sleepers. The channel, rolled from a special quality of steel, had a specific resistance as low as 0·0000105 ohm at 24° centigrade. The actual leakage on the entire system, including generating dynamos, feeders and working conductors, was in general 0·5 ampère, corresponding with a loss of 0·3H.P. The return circuit was through the rails, which were uninsulated, and the method of dealing with the conductor at points and crossings was described.

The use of the uninsulated rails as the "return" was discussed, as well as the effect of the earth currents thereby generated. Observations at the Royal Observatory, Greenwich, as also those made by Professors Ayrton and Rucker, showed that, in addition to the earth currents, there were magnetic effects perceptible at considerable distances from the line. These disturbances were, however, small, and of no practical importance in connection with the working of telegraph and telephone systems in the vicinity.

The essential and novel feature in the design of the locomotives was that the armatures of the motors were built directly upon the axles, whilst the magnets were supported partly on the axles, and partly on the frames; thus, gear of any description was entirely obviated, and the mechanism was reduced to its simplest elements. It was shown that the system of direct driving did not require a greater deadweight upon the line than was usual in ordinary locomotive practice; and that no injurious effects upon the armatures could be traced to vibration. The total weight of each locomotive was 10 tons 7cwt., the length over the buffers being 14ft., and the wheel-base 6ft.

The two motors on each locomotive on the City and South London line were both capable of developing 50H.P., corresponding with 310 revolutions of the axle per minute. The magnets were of the "Edison-Hopkinson" form, series wound, the armatures being of the Gramme-ring type. The tractive force of the locomotives, with a current of 100 ampères, was 1180lb., and the maximum tractive force 3000lb.

The trains were fitted with the Westinghouse continuous automatic brake. Instead of a pump working continuously on the locomotive, the latter was provided with reservoirs placed under the curved side plates of the cab, and charged with air at a pressure of 80lb. at the end of each journey. The reservoirs were of sufficient capacity to provide for about 30 stops from full speed.

The efficiency of an electric-railway system might be considered under three heads:—(1.) The production of electrical power; (2.) Its distribution. (3.) The reconversion of electrical power into mechanical power.

With regard to the first head, it was shown that the daily consumption of electrical energy, with eight trains in constant work, was about 3700 units, which were produced by the combustion of 7·51b. of Welsh coal per unit. As in the case of electric-lighting stations, the efficiency of production of electrical power was greatly reduced owing to the variations of load. The average load on the generating engines and dynamos was only about one-half their full load, and consequently they could not work under conditions of maximum efficiency.

The distribution of electrical power was shown to be strictly in accordance with Lord Kelvin's well-known principle—that the cost of power absorbed in the conductors should be equal to the charge for interest on the capital invested in them. Thus the cost of distribution was a minimum. The average loss in the conductors was about 10 per cent. The average efficiency of the locomotives, under the actual conditions of running, was shown to be 70 per cent., and the electric efficiency of the entire system was 62 per cent. These results substantiated the estimates of efficiency given in evidence before the Parliamentary Committees on the Central London Railway Bill by Sir Benjamin Baker and Dr. John Hopkinson.

The cost of working the railway in successive half-years was deducted from the company's half-yearly returns; and it was shown that the present cost of running, including all expenses of working and maintaining the generating station and locomotives, was 6·3d. per train mile —or 20 per cent. less than the cost guaranteed by Messrs. Mather and Platt. The cost of repairs of the generating plant and locomotives was only 0·39d. per train mile. The trains, when normally loaded, weighed 40 tons, and accommodated 100 passengers. Their average speed, including intermediate stoppages, was 11·5 miles per hour, and that of actual running between stations 13·5 miles per hour. The maximum speed attained between stations varied from 20 to 25 miles per hour. The train mileage for the half-year ending December 31, 1892, was 214,417. Since the opening of the line two years ago, the locomotives had run more than 820,000 miles, and had dealt with a traffic of over 12,000,000 passengers.

Goold's Pulley and Belting Calculator.

We have received from Messrs. Elliott Brothers, 101 and 102, St. Martin's-lane, London, a new form of slide rule specially arranged for calculations relating to pulleys and belting. The instrument, which has been devised and patented by Mr. W. T. Goold, consists of a boxwood rule 12½in. long by 2½in. wide by ¼in. thick, and fitted with two slides, one on each face. One side relates more particularly to pulleys, and the other to belting. The edges of the rule are divided off into inches and centimetres. By using the pulley side the calculator gives the solutions of such problems as the following:—Given the diameter and number of revolutions of a pulley to determine its circumferential velocity; or, the two converse problems: Given the diameter and number of revolutions of a driving pulley, to find the number of revolutions of a driven pulley; or, Given the diameter of a pulley, to find its circumference.

By the aid of the belting side of the rule the width of belt to transmit a given horse-power at a given speed may be readily determined, as well as the speed or horse-power, when the other factors are given. A novel feature of the rule is the provision of a small sliding indicator, by the adjustment of which the strength, etc., of belting may be calculated for various working loads of from 50 to 110lb per inch of width. That some such provision is necessary is evident from the following list of working loads given by different authorities:—Molesworth, 50lb.; Morrin, 50lb.; Cooper, 55lb.; Box, 58lb.; Armour, 65lb.; Unwin, 70lb.; Cowling-Welch, 70lb.; Hussey, 80lb.; and Thurston, 100lb. We may add that results are given for both single and double belting, and that the calculations are based upon a contact of 40 per cent. of the circumference of the smaller pulley. The rule gives very trustworthy results for most ordinary conditions of length of drive and velocity, and will doubtless prove of great service to those who frequently require to make similar calculations to those above indicated.

Hull and District Institution of Engineers and Naval Architects.

On Monday, the 13th inst., the members of the above institution assembled to hear a paper by Mr. W. H. Willatt, electrical engineer at Messrs. Earle's Company Limited, on "A Few Practical Notes on Electrical Distribution for Marine Purposes." Mentioning first the various uses to which electricity is already put in the navy—for lighting, gun-firing, torpedo-firing, voice-pipe communication, bell service, submarine mining, etc.,—the author stated that he proposed dealing only with one branch of the above—viz., electric lighting, as the time was limited, and the subject, as a whole, was so extensive.

Comparison was first made between the difficulties of electrical distribution on land and on shipboard. On land the difficulties are few compared with those on ship, the greatest enemy of all in the latter case being, perhaps, salt water, which is a great destroyer of good insulation. The various methods of distribution were then fully entered into, and the advantages of the double-wire system over the single-wire pointed out. The designs of switchboards, distributing boxes, cut-outs, sheathing and insulating cables, joints and lamp fittings were referred to. The advantage of vulcanised fibre boiled in paraffin wax over slate for baseboards where there is much vibration (as in gun firing) was next dilated upon, as also were the methods of passing cables and wires through decks, bulkheads, etc. The drawings by which these items were illustrated deserve special mention. A short discussion, followed by a hearty vote of thanks to the author, brought the meeting to a close.

Metal Trade Memoranda.

The four mills at the Morriston Tinplate Works, Swansea, which have been lying idle for some months, are now in full work. We understand that the Midland Tinplate Works, which are the property of the same company, will shortly be in full work again.

The blast furnaces at the Clyde Ironworks have been damped down for the purpose of forming a connection with the ammonia works which have recently been constructed. It is expected that they will be ready for use again in about three weeks.

Messrs. Dorman, Long and Co. have resumed operations at the Britannia and West Marsh Works, Middlesbrough, after a stoppage which has lasted since Christmas. This was partly due to putting down new plant.

The second of the blast furnaces at the Cleator Moor Ironworks was blown out on the 18th inst., and the works closed for an indefinite period. The notice to the men at the Lowther Ironworks, Workington, also expired on the same date. In the West Cumberland and Furness districts 34 blast furnaces are blowing, as against 42 during the corresponding period of last year.

Official Gazette.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Order made on Application for Discharge.

Silberberg, Victor (trading as the Electrical Fittings Manufacturing Company), Oxford-street, W., electrical fittings manufacturer—discharge suspended for two years, ending Jan. 17, 1895.

The Metal Market.

PRICES CURRENT.

LONDON, Feb. 20.

Copper opened firm, with near positions 1s. 3d. better, cash making £45 3s. 9d., and values were well maintained, buying being of moderate extent. After a while three months followed the advance of £45 13s. 9d., and cash in four days made £45 5s. At the close there were buyers at £45 3s. 9d. cash and £45 13s. 9d. three months, with sellers at 1s. 3d. more, the tone being steady. From 21 to 23 days made £45 6s. 3d. to £45 7s. 6d. Sales, 600 tons. Settlement price, £45 2s. 6d. English tough, £48 5s. Best selected, £49 to £49 10s. Strong sheets, £57 to £57 10s.

Tin has been firm at an advance of 2s. 6d., cash changing hands at £91 17s. 6d. There were few sellers for distant delivery owing to light offerings from the Straits, and 18 days made £92, three months £92 10s., and two months £92 6s. 3d. Sales, 50 tons to 60 tons. Settlement price, £91 17s. 6d. English ingots, £95 to £95 10s.

Pig Iron has ruled quiet, with much reserve as regards cash offerings. No business transpired, the nearest approach being a bid of 41s. 7½d. for three months fixed, which was offered at 41s. 9d. Settlement prices:—Scotch, 50s.; Middlesbrough, 35s.; hematite, 45s. 7d.

Tinplates quiet at late rates. I.C. cokes, f.o.b. London, 12s. 6d. to 12s. 7½d.; Liverpool, 12s. to 12s. 1½d.; Swansea, 11s. 6d. to 11s. 7½d.

Lead is easy, the nearest price of Spanish being £9 7s. 6d. English, £9 10s. to £9 12s. 6d.

Spelter had a nominal market at £16 17s. 6d. to £17 for February shipment.

Zinc Sheets.—Silesian unchanged and dull at £20 2s. 6d. ex ship. Belgian quiet. V.M. brand, £20 17s. 6d. ex ship, and £20 15s. f.o.b. Antwerp.

OFFICIAL CLOSING QUOTATIONS.

	To-day.					
Copper—	£	s.	d.	£	s.	d.
G. M. B.—Cash	45	3	9—	45	11	3
" Three months	45	13	9—	46	1	3
English tough		—	—	—		
Best selected		—	—	—		
Strong sheets		—	—	—		
Tin—						
Fine foreign—Cash	91	17	6—	92	7	6
" " Three months	92	10	0—	93	0	0
Australian—Cash	92	7	6—	92	17	6
Pig Iron—					s.	d.
Scotch warrants—Cash					—	
" One month					41	9
Middlesbrough—Cash					35	0
" One month					—	
Hematite—Cash					45	7½
" One month					—	

GLASGOW, Feb. 20.—The pig-iron market was somewhat excited, as some buyers had to cover "short" sales. Only two lots of Scotch were forthcoming at the forenoon session, and they fetched 50s. 6d. and 51s cash, being highest open prices paid since the squeeze began. Nothing was doing at afternoon market, but 1500 tons sold privately at 52s. and 53s. cash. Great efforts are being made to create warrants, and 18 scales are in use weighing in iron at Connal's Stores. The shipments of Scotch last week were 3569 tons, being a decrease on last year of 3258 tons, making the decrease for the year 7743 tons.

QUOTATIONS.

	Highest.		Lowest.	
	s.	d.	s.	d.
Scotch warrants—Cash	51	0	50	6
" One month	—		—	
Middlesbrough—Cash	35	0	35	0
" One month	—		—	
Hematite—Cash	45	7½	45	7½
" One month	—		—	

New Companies.

Credenda Tube Company Limited.—This company was registered on the 14th inst., with a capital of £100,000, in £10 shares, to acquire the business of tube makers hitherto carried on by the Credenda Seamless Steel Tube Company Limited, to carry on the business so acquired, to develop and extend the same, and generally to follow in all or any of their branches the businesses of tube-makers, steel-makers, ironmasters and founders, mechanical engineers, bridge builders, machine and implement

makers, locomotive and wagon builders, boiler-makers, copper and brass founders, smelters and workers in any metals, colliery proprietors, and manufacturers of and dealers in all products and substances which can be made or extracted from ores, metals, minerals, coal, earth, shale or rocks. The number of directors is never to be less than 3, nor more than 10; and the first are to be appointed by the subscribers to the memorandum of association; qualification, £1000; remuneration, £1200 — divisible. Registered by Grundy, Kershaw, Saxon, Samson and Co., 14, New Court, Lincoln's Inn, W.C.

TUCKINGMILL FOUNDRY AND ROCK DRILL COMPANY LIMITED.—This company was registered on the 14th inst., with a capital of £50,000. in £5 shares, to take over as a going concern the partnership, business, and undertaking hitherto carried on by G. J. Smith, William Bickford-Smith, H. Phillips Vivian, and J. R. Daniell, at Tuckingmill, Cornwall, under the style of "The Tuckingmill Foundry Company"; also to acquire and take over from J. McCulloch, of Bella Vista, Merridale-road, Wolverhampton, Staffordshire, all the patents and patent rights of and in the rock-drill and an air-compressor patented by Mr. McCulloch, together with his business; to enter into a certain agreement, and to carry on the businesses of brass and iron founders and manufacturers and makers of engines, and mining and other engineering plant, materials, and utensils; manufacturers and dealers in rock-drills and air-compressors, with all adjuncts and accessories. The number of directors is not to be less than 3, nor more than 7; the first being G. J. Smith, J. V. Bickford, T. H. Hekewich, H. P. Vivian, and A G. White; qualification, £500; remuneration, to be fixed in general meeting. Registered office, 1, Chapel-street, Camborne, Cornwall.

Letters to the Editor.

**** We do not hold ourselves responsible for opinions expressed by correspondents.*

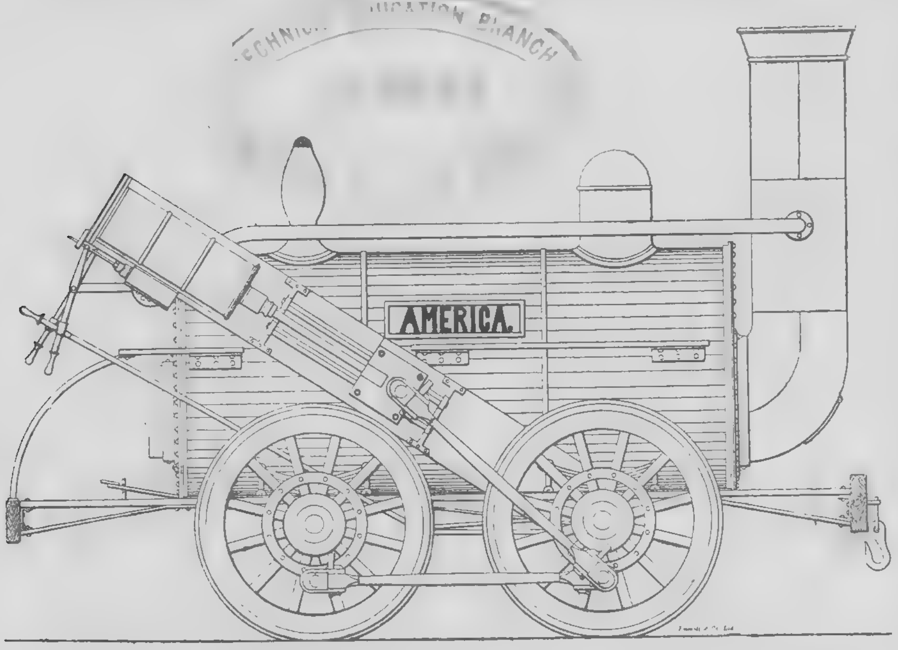
**** The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

**** Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

THE FIRST LOCOMOTIVE FOR AMERICA.

To the Editor of THE MECHANICAL WORLD.

SIR,—Early in the year 1828 the Delaware and Hudson Canal Company, having heard of the success of the Stockton and Darlington Railway, sent over Mr. Horatio Allen to England with instructions to obtain information and purchase rails and four locomotives. He gave an order to Messrs. Foster, Rastrick and Co., of Stourbridge, for three, also to Mr. Stephenson for one. Stephenson's engine was named "America"; it was built in 1828, and arrived in New York on board the ship "Columbia" about the middle of January, 1829. It was the first railroad locomotive engine ever seen in America, and is here illustrated. The following is a copy of the official description :—



No. 12 LOCOMOTIVE, "AMERICA," DELAWARE AND HUDSON CANAL CO. (R. STEPHENSON AND CO., ENGLAND, ENGINEERS, 1828).

Wheels, 4ft. coupled; Boiler, 4ft. dia., 9ft. 6in. long; Cylinders 9in. dia., 2ft. stroke.

DESCRIPTION OF THE LOCOMOTIVE ENGINE "AMERICA," BUILT BY R. STEPHENSON AND CO. FOR THE DELAWARE AND HUDSON CANAL COMPANY TO THE ORDER OF MR. HORATIO ALLEN, 1823, AND NO. 12 IN THE BOOKS OF THE MAKERS.

	ft.	in.
Diameter of boiler	4	1
Length of boiler	9	6
Dimensions of fireplace ....4ft. ×	3	0
Diameter of steam cylinder	0	9
Length of stroke	2	0
Size of chimney	1	8
Size of hot-water pump	0	1½
Length of stroke of ditto	2	0
Wheels (wood), diameter	4	0

Number of wheels, 4.

Angle of cylinders to the horizontal, 33°.	ft.	in.
Size of tubes	1	7

Number of fire tubes, 2. Tubes were straight.

CLEMENT E. STRETTON, C.E.

Saxe-Coburg House,
Leicester, Feb. 10.

THE TRAINING OF YOUNG MARINE ENGINEERS.

To the Editor of THE MECHANICAL WORLD.

SIR,—I should like to remind our friend who is so anxiously concerned about the training of young marine engineers that there remains at present a system of engine driving which, I think he will agree with me, ought to be abolished. I refer to the system where men have charge of engines and boilers without a certificate. Take, for instance, the tugboat men, the majority of whom have no certificate, yet are allowed to take engines and boilers to sea before they can understand the feeding of a boiler or the oiling of an engine. They are likewise ignorant of the density of boiler water or the amount of coal used per horse-power. I can quite understand their system of working, and as a seagoing engineer myself I quite agree with our friend when he says, regarding the training of young engineers, that everyone, before he can take charge of a watch or the management of engines and boilers, ought to produce a certificate of a certain grade allowed by the Board of Trade. Even donkeymen on board a ship should have a certificate qualifying them to take charge of a donkey boiler. To keep, however, to the subject of young engineers, I think the majority of young men know very little about boilers when they are out of their time, since they do not see much of boiler work in the workshops, being always kept at the one class of work—either fitting, erecting, or turning, but very seldom in the boiler-shop putting on boiler connections. For instance, here is a young fellow out of his time. He goes to sea for 18 months or so, comes home, goes up for examination, as our friend says, and gets his blue paper, and is rated as second. He goes to sea again, and before he is 24 years of age becomes chief engineer, and the happy possessor of a good salary per month. What for? Not for his long experience or practical knowledge of the trade, but because of his rating, which very often makes him independent, bigoted, and full of conceit, and instead of harmony prevailing on board ship, there is often discord. Why does this happen? Because, perhaps, the second engineer is an older man than the chief, and thinks he knows more; and very likely the third is an older man than the chief, and he thinks the same as the second, so that there is a malicious feeling existing which very often ends in serious results.

A READER OF "M. W."

Hartlepool, Feb. 18.

AVOIDANCE OF SMOKE.

To the Editor of THE MECHANICAL WORLD.

SIR,—Gas for heating purposes is usually made without obtaining any coke or bye-products. The coal is all burnt to ash, the tar destroyed, and much incombustible carbonic acid and nitrogen caused to mix with and to an important extent nullify, the gas. This is very uneconomical. Gas for heating purposes can be made in such a way as to leave a coke of far more value than ordinary gas coke, and when so made will retain all its bye-products (tar, ammonia, and benzol), which, although now selling at very low prices, will realise quite 4s. per ton of coal. The coke will be worth 6s. to 8s., and, as the coal (the smallest slack) and labour will not cost more than 9s. per ton — in the manufacturing centres, — the gas will cost absolutely less than nothing, and will give more heat than the coal from which it is obtained does when burnt in the ordinary way. This is no mere theory. It has been proved to demonstration. Your correspondent "W." is right in suggesting that for domestic fires coke should be used with the gas. Corporations of towns should make and supply both—the coke at 10s. per ton, and the gas at 6d. per 1000ft. Imagine users of gas engines getting their gas at 6d. per 1000ft. ! At these prices they would get a very large profit, which would go in reduction of rates. Small factories, blacksmiths, and others using up to 20 tons per week would find it economical to get their gas and coke from the Corporation (using no coal, of course); but the larger works, having room, could more profitably have their own gas and coke plant. Whenever this process is generally adopted (and the time will assuredly come), there will not be a particle of smoke from any chimney at any time. All tall chimneys can be pulled down, manufacturers and householders will save largely on their fuel, and our coalfields will have a new lease of life.

It only requires a few people with money to "start the ball," and everybody will soon want to be "in at the game." Why cannot a company be formed to supply a small town first?

T. NICHOLSON.

Tudno Villa, Colwyn Bay,
Feb. 21.

Miscellaneous Items.

The Butcher's Guild of Copenhagen is having an electric tannery constructed in that city, the installation being effected by the engineering firm of Messrs. Monies and Andersen. This is the first electric tannery in Scandinavia.

Some experiments have recently been carried out on a Russian war vessel regarding the adoption of electromotors in place of the numerous small steam engines arranged in the various parts of the vessel. The experiments proved very successful.

The example of Dolgelly has caused the question of the adoption of the electric light in Llangollen to be seriously discussed. The Local Board has resolved itself into a committee to consider the advisability of using arc lamps for the public lighting of the streets.

The increased cheapness of nickel, owing to the large output of the Canadian mines, is leading to a more extended use of this valuable metal. Only lately it was mentioned that the French Government proposed to use 400 tons in nickel coinage. Austria is also about to follow her example.

Some kinds of fireproof porous goods are made of asbestos fibres ground to a fine powder, mixed with water, kneaded, mixed with water again, dried, and again kneaded and pressed in moulds. If heated to 1700° C., a mass like porcelain is produced. Heated to 1200° C. for 18 hours, it gives a porous mass.

A meeting has recently been held in Berlin, comprising representatives of all the existing electrical societies throughout Germany. The object of the meeting was to consider the steps necessary to be taken for the formation of a general German Institution of Electrical Engineers. A provisional committee was organised, with Professor Dr. Slaby as president, with powers to act until the 1st October next.

Among the exhibits on view at the Yachting Exhibition, now being held at the Royal Aquarium, Westminster. London, is an invention for throwing a line at sea by the aid of a rocket. The apparatus consists of a patent adjustable socket, which can be fixed to the rail of a ship in any part of the vessel. The tube in which the rocket rests before it is fired can be elevated to any position, and may be used almost at a moment's notice.

The Admiralty have decided to add another class of gunboats to the Navy, and in the new estimates provision will be made for 13 of them, all of which are to be built by contract. The new vessels are to be termed torpedo-boat destroyers, and in size they will be between a torpedo-catcher of the "Sharpshooter" class and a first-class torpedo-boat. Their armament is to consist of one 12-pounder and three 6-pounder quick-firing guns, in addition to which they will be supplied with five 18in. torpedoes for use in a bow tube and two revolving tubes amidships.

Prize Competition.

WE OFFER FOUR GUINEAS MONTHLY IN PRIZES FOR THE BEST ORIGINAL ARTICLES SENT IN ON ANY MECHANICAL, ENGINEERING OR ELECTRICAL SUBJECT.

IN ORDER THAT MANAGERS, DRAUGHTSMEN, FOREMEN, AND WORKMEN WHO HAVE HAD NO PRACTICE IN WRITING MAY NOT HESITATE TO SEND IN COMPETITIONS, IT IS TO BE UNDERSTOOD THAT ALL ARTICLES WILL BE FULLY EDITED AND CORRECTED, AND JUDGED OF SOLELY ON THEIR MERITS AS ORIGINAL CONTRIBUTIONS FROM A PRACTICAL POINT OF VIEW. THE OBJECT OF THE COMPETITION IS TO INDUCE PRACTICAL MEN TO COME FORWARD AND GIVE THE RESULTS OF THEIR EXPERIENCE.

CONDITIONS.

Competitions for our Monthly Prizes must be sent so as to arrive at the Manchester Offices of THE MECHANICAL WORLD, New Bridge-street, not later than the last Tuesday in each month. Articles arriving after that time will be placed in the following month's competition.

Written competitions must be on one side of the paper only. The contributions must be original, and relate to matters connected with Engineering, Mechanism or Electricity.

The Proprietors of THE MECHANICAL WORLD reserve the right to publish any competition, whether it gains a prize or not.

The competitions may be accompanied by diagrams, sketches or drawings.

Competitors should write the words "Prize Competition" on the envelopes.

Competitors are not confined to one, but may send any number of competitions.

The correct name and address of the sender *must* be distinctly written upon every competition, not necessarily for publication. Competitions can appear under a *nom de plume.*

☞ We cannot undertake to be responsible for any MSS. sent to us, though when stamps are enclosed for the purpose we will endeavour to return rejected contributions.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

DISINFECTANT.—Will any reader kindly tell me how to make a cheap and effective disinfectant powder?—BOILERS.

IRON MANUFACTURE.—Required, particulars of the Husgafel process of making iron blooms direct from the ore.—F. C.

FILTRATION.—Will any reader state the best method of filtering 150 gallons of canal water per day for steam-boiler purposes?—T. H. MITCHELL.

TWIST DRILL CUTTERS.—Can any reader give me a method of getting the correct thickness and shape of cutter for any diameter of twist drill, straight lip? A drawing will greatly oblige.—J. M. F.

ENGINEERS' WAGES.—Would any reader kindly give me some information as to the wages at Cape Colony and Mexico for mechanical engineers?—REGULAR READER OF "THE MECHANICAL WORLD."

RUST JOINTS.—How can I stop leakage in a vertical joint (rust joint) in my hot-water pipes (low-pressure system) without cutting out the packing? Would any fluid cement percolate into the crevices and harden there?—B.

MAKERS OF BUILDERS' IRONWORK.—Can any reader furnish me with addresses of firms who are makers of machinery for making builders' iron work, such as bands and hooks, cavity irons, etc.?—SMITH.

LOCOMOTIVE.—Will any reader of THE MECHANICAL WORLD kindly give me the best way to trammel a locomotive which has too much play in the axle boxes and more on one side than the other? There are no centre marks on the crankpins.—DUBBS.

BOILING COPPERS.—What is the grate area required to boil five 100-gallon coppers and one 50-gallon copper? Said coppers are steam jacketed; inside of copper, outside of wrought iron; boiler pressure 80lb., reduced to 7lb. before reaching coppers. Will be glad of rule for calculating above.—G. HAYWOOD.

CONVEYING DEVICE.—I want to remove cut straw, ⅜in. long, from chaff cutter to a room distance 60ft., round one curve, at the rate of 5 tons per hour. What size tube shall I require, and how can I do it by means of a blast fan so that the chaff does not go through the fan? Would sanitary tubes do for the purpose, underground?—PUZZLED.

DYNAMO SHAFT.—I should be much obliged if the author of "The Design and Construction of Stationary Engines," or some other reader, could give me a formula (or refer me to any book where I could find it) for arriving at the size of shafts for dynamos and motors; given distance between bearings, weight of armature and pull on periphery of same in lb. Any information with respect to this would be much appreciated.—A YOUNG ELECTRICAL ENGINEER.

EXHAUST STEAM.—Could any of your numerous readers give me any information as to how to dispose of exhaust steam from a donkey feed-pump, and say if it would be right to put the exhaust steam into the feed-water on the suction side, and what arrangement is required for this? The water is at present 80° F., and the pump has to lift it 12ft. Will the pump work satisfactorily if the exhaust steam be put into water at 80°.—INJECTOR.

FEED-WATER HEATERS.—Would someone kindly inform me how to calculate and give all particulars of a plain wrought-iron vertical or horizontal cylindrical feed-water heater; number of tubes, diameter, and heating surface, height and diameter of wrought-iron cylinder, and whether brass or wrought-iron tubes would be best, for an engine with 16in. cylinder by 2ft. 3in. stroke, making 70 revolutions per minute? Steam pressure, 60lb per square inch; cut-off at ⅝ stroke; size of exhaust pipe, 5in. diameter; steam pipe, 4in. diameter; exhaust steam to pass through heater tubes. How much larger would heater have to be for a pair of engines with cylinders as the one above?—FEED WATER.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

J. W. B.—See reply to "E. X."

P. S.—We are sorry we are unable to assist you.

R. W.—By all means use iron plates of the same thickness.

.MIDGLEY.—Tilghman's Patent Sand Blast Company, Bellefield Works, Sheffield.

J. H. B.—We recollect seeing the announcement in print, but no address was given.

GEARING.—They are measured on the pitch line, from centre to centre of contiguous teeth.

E. X.—Apply to the Secretary of the Marine Department, Board of Trade, Whitehall, London.

T. S. F.—We think Spretson's "Iron Founding," 18s., will meet your requirements. It may be had from this office.

T. BINNS.—If you send us a rough sketch of the valve arrangement, together with an indicator diagram, we will endeavour to assist you.

TOYS.—We believe that Messrs. W. H. Wallwork and Co., Union Bridge Ironworks, Charter-street, Manchester, will be able to supply you with what you require.

H. E. HODGSON AND CO.—The company do not give any address, but you will no doubt be able to obtain it by applying to Messrs. Waterlow Bros. and Layton Limited, London Wall, London, E.C.

M. H. C.—Several arrangements have been patented from time to time, but we do not know of any firm who make them. We should think Messrs. Kerr, Stuart and Co., 20, Bucklersbury, London, would be able to assist you.

SUBSCRIBER.—With a head of 100ft., a pressure of 43·31lb. per sq. in. would be exerted upon the bottom of the pipe. The same pressure would be exerted against the side close to the lower end, becoming gradually less as the top of the pipe is approached.

S. DARLINGTON.—We think the commonly accepted method the more correct. You must recollect that the steam enters the cylinder through a comparatively small opening, and any kinetic energy it may possess is dissipated instantly.

A. COX (Falmouth).—"Mining and Ore Dressing Machinery," by C. G. W. Lock, price £2 12s. 6d.; "The Assayer's Guide," by Oscar M. Lieber, price 6s. 6d.; "Surveying," by G. W. Usill, price 12s. 6d. The above may be had from our office.

FLOTATION.—If the system is in equilibrium the tension on the wire will be equal to the weight. As to the varying tension on the wire, this would depend upon the rate at which the water level varied. Neglecting friction, the counter-weight would require to be equal to the weight of the float minus the weight of water it displaces.

RUST.—The following is the paragraph you refer to:—"In order to keep machinery from rusting, take 1oz. of camphor and dissolve it in 1lb. of melted lard; take off the scum, and mix as much fine black lead as will give it an iron colour. Clean the machinery and smear it with the mixture. After twenty-four hours rub clean with a soft linen cloth.

HEATING FURNACE.—Will any reader kindly give particulars, with rough sketch, of furnace suitable for heating and fagotting iron up to 3in. diameter and about 2ft. long for 2cwt. steam hammer?—HAMMER.——*A.*—If "Hammer" will state weight or quantity of iron required to be turned out per shift, or per day, in his furnace I shall be glad to give him a sketch of one to turn out the work he mentions, such as are used by the leading railways, wagon-building, and iron-making companies.—MALVERN.

COAL MINING.—Will some reader of THE MECHANICAL WORLD kindly say how many tubs should be run each journey to work an incline of 1 in 14 and 1100ft. long, so arranged that the full tubs going down will bring up the empty ones? Weight of tubs, full, 15cwt.; empty, 5cwt. each; would two tubs each journey be sufficient? Which would be the best to lower the tubs with—a brake drum or a horizontal brake pulley? Please say how to calculate the weights for working inclines of various gradients when arranged as the above.—AUTOMATIC.——*A.*—Would two tubs be sufficient each journey to work an incline of 1100ft. long, rising 1 in 14, the weight of a full tub being 15cwt. and an empty one 5cwt.? This incline will work three of the tubs above mentioned. I would let them down by a horizontal brake pulley. The weights for working an incline plane can be found from the following formula:—Height of incline = H; length of incline = L; weight of full set in lb. = F; weight of empty set in lb. = E; time running in seconds = T; gravity = G = 32; weight of rope in lb. = R; coefficient of friction of tubs on level road = m = 0·01; coefficient of friction of rollers and sheave 0·03 of their weight on the average = m^1; weight in lb. of the whole mass in motion—

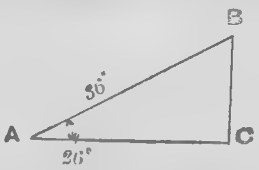
$$\frac{H}{L} = \frac{m(F+E)+m^1 S + \frac{W\cdot 2L}{gt^2}}{F-(E+R)}$$

—D. HOPKINS.

WINDING ENGINE.—What weight would a pair of 36in. cylinder engines by 4½ft. stroke raise from a pit with a spiral drum, commencing at 14ft. and finishing at 18ft. diameter, one side to wind from a depth of 350yds. and the other side from 400yds.; ropes to be 1½in. diameter, boiler pressure 80lb. per square inch, cut-off at ¾ stroke? What weight would the above engines raise from a depth of 280yds., with a flat rope drum, commencing at 12ft. diameter; sizes of ropes 5½in. by ⅝in. (steel)? What would be the rise in inches per yard of a slant whose angle is 26 degrees?—MINER.——*A.*—To find the load which a given pair of engines will start, multiply the area of one cylinder by the pressure of steam, and twice the length of stroke. Divide this by the circumference of the drum, and deduct one-third for friction. The result is the load the engines can start. In this example we have area of cylinder = 1017·8784 sq. in.; mean effective pressure of steam = 62·521lb.; length of stroke = 4½ft. Thus we have

$$\frac{1017{\cdot}8784 \times 62{\cdot}521\text{lb.} \times 9\text{ft.}}{43{\cdot}9824} = 13{,}023 - \tfrac{1}{3}, \text{ or } 4341$$
$$= 8682\text{lb. the load.}$$

This load comprises the rope and coal, because the cages and tubs balance each other. The other part of the question can be worked out as follows. The rise in



inches per yard of a slant whose angle of incline is 26° is about 15·7814in., which is worked out as follows:—$\frac{BC}{AB}$ = sin A - 10. B C = A B × sin A - 10 ∴ by logarithms; log. B C = log. A B + log. sin A - 10 = log. 36 + log. 26° sin - 10 = 1·5563025 + 9·6418420 - 10 = 1·1981445. Log. 15·781 = 1·1981345, log. 15·782 = 1·1981620.

$$\left.\begin{aligned}\text{Log. } 15{\cdot}782 &= 1{\cdot}1981620\\ 15{\cdot}781 &= 1{\cdot}1981345\end{aligned}\right\}\text{subtract.}$$
$$0{\cdot}001 = 0{\cdot}0000275$$

Then 1·1981445 - 1·1981345 = 0·0000100. Then we reason thus: As 0·0000275 : 0·0000100 :: 0·001 : quantity added

$$= \frac{100 \times 0{\cdot}001}{275} = 0{\cdot}0004,$$

Therefore, 0·0004 must be added to 15·781 = 15·7814in., the rise per yard of the slant.—D. HOPKINS.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

2nd February, 1893.

2350 CHUCKS for LATHES. T Dodd and G Oulton.
2353 VICES. G G Potter.
2355 ELEVATED TRACKS, TRAMWAYS, or WIRE-WAYS.* A J Boult. (*W P Walling* and *T L Martin*, United States.)
2359 AUTOMATIC RAILWAY BRAKES. E Farnsworth.
2365 RAILWAY BRAKE APPARATUS. M L E Duval.
2366 LINED or COMPOUND METAL TUBES. L Petry.

3rd February, 1893.

2375 INSULATING SUPPORTS for ELECTRICAL CONDUCTORS. A R Bennett.
2377 REHEATING FURNACE for STEEL and IRON PUDDLING. A Allen and others.
2381 SHIPS' TELEGRAPHS. J W Ray.
2382 ADJUSTABLE VALVE TAPS. C Horton.
2383 HYDRAULIC CONNECTION. J Haynes.
2384 APPARATUS for "PUTTING ON" and PRESERVING the CENTRE LINE in SINKING DEEP PITS or SHAFTS.* W Foulstone.
2385 BALL BEARINGS. I M Bourke.
2388 FURNACES for the BETTER CONSUMPTION of FUEL. A Boswell.
2389 COMPENSATING DIFFERENTIAL ADJUSTING STOP and LOCK NUT. J Smith.
2392 SPRINKLERS for the EXTINCTION of FIRE. J R and S Platt.
2393 TOOTHED WHEELS and DRIVING PULLEYS. L Billing.
2394 NUT-LOCKING DEVICES. T P Carswell.
2398 FURNACE FIREBARS. J T Wood and J A Brodie.
2399 FURNACES.* J A and S Fletcher.
2401 VALVE MOTION and CUT-OFF for STEAM ENGINES. A T Mirza.
2402 ELECTRICAL ALARM in CONNECTION with STEAM GAUGES. A T Mirza.
2403 DISTRIBUTING ELECTRICAL ENERGY. J A Kingdon.
2410 SIGNALLING the PASSAGE of the LAST VEHICLE of a RAILWAY TRAIN. W E Langdon.
2413 COMPOUND BALANCED ENGINE. F A Roche.
2415 STOP VALVE or TAP. J Robinson.
2416 STOP VALVE or TAP. J Robinson.
2418 SUPPLYING PURIFIED and HEATED FEED-WATER to the BOILERS of NON-CONDENSING STEAM ENGINES. G E Hudson and G Sanderson.
2419 AIR RELIEF VALVES for HOT-WATER BOILERS and RADIATORS. J Keith.
2422 SIGHT-FEED LUBRICATORS. R Wilson.
2430 PORTABLE PUMPING APPARATUS. D Noble and J A Brown.
2433 SMELTING of IRON ORE in the PRODUCTION of PIG IRON. H C Bull.
2437 APPARATUS for SETTING a RAILWAY SIGNAL at DANGER by the ACTION of a PASSING ENGINE. H G Dallimore.
2449 FURNACE for TREATING and REDUCING ORES. P Willis. (*L A Allard*, United States.)
2450 MARINE GOVERNORS. S Dyson.
2451 STOP VALVES for HIGH-PRESSURE STEAM and OTHER FLUIDS. G Payne.
2452 SHIELDS or GUARDS for WATER GAUGES. J A and J Hopkinson.
2455 FRICTION COUPLING for the CARBON FEED MECHANISM of ELECTRIC ARC LAMPS.* J Jergle.
2458 FURNACES. C T J Vautin and J R Thame.
2462 TRAIN SIGNALLING APPARATUS. J W Maycock.
2466 NUT LOCKS. F J Reynolds and S D Williams.

4th February, 1893.

2472 APPARATUS EMPLOYED in FOG SIGNALLING on RAILWAYS. J G Dixon.
2475 STEAM WINCHES and CRANES. T Scott.
2491 GRIP PULLEYS.* W N Colam.
2494 TELEPHONE ANNUNCIATORS. A Whalley.
2496 SEA ANCHOR. C H Thompson.
2498 ATTACHMENTS for WOOD MOULDING MACHINES. W W Horn. (*D B M Shelley* and *L G Kilmer*, United States.)
2502 APPARATUS for STREWING SAND on RAILWAY LINES. A Bruggemann.
2520 AUTOMATICALLY INDICATING and REGISTERING the SCORE OBTAINED in ELECTRIC TARGET PRACTICE. A J Eli.
2524 IMPROVED FUEL. M Cameron.
2527 CABLE or ROPE TRACTION APPLIED to the WORKING of STREET TRAMWAYS. J Sturgeon.
2531 VALVE GEAR for DUPLEX STEAM PUMPING ENGINES. T Holehouse.
2535 HEATING of the FEED-WATER of STEAM BOILERS. J Murrie.
2536 FEED-WATER HEATERS. J Murrie.
2537 ADJUSTABLE SPANNERS. T Breakell.
2544 PORTABLE NIPPERS for GRIPPING ROPES. W P Bullivant.
2547 PURIFYING WATER and APPARATUS THEREFOR.* D H Lyon. (*D Hanna*, United States.)

6th February, 1893.

2552 CONSTRUCTION and CONTROL of ARC LAMPS. P Pippette.
2557 ELECTRICALLY-DRIVEN SCREW PROPELLERS. H T Barnett.
2583 ELECTRICAL INDICATORS. G Hayward.
2586 DIAPHRAGM for ELECTROLYTIC CELLS. C N Waite.
2587 AXLE BEARINGS. T Severn and others.
2591 ROLLER MILLS. E Kieg.
2592 A MICROPHONIC AMPLIFIER of SOUND. E Hardy.
2593 TELEGRAPH POLE FITTINGS. J C Fuller and others.
2596 HYDRO-CARBON MOTOR. J C Lanyon. (*J Martin*, Australia.)
2598 PROCESSES for EFFECTING the ELECTRO-DEPOSITION of METALS UPON ALUMINIUM. D Abel. (*G Lehnert*, Germany.)
2600 ELECTRIC INCANDESCENT LAMPS. R Haddan. (*G Dedreux*, Germany.)
2604 BOILER TUBES and FLUES. D Purves.
2606 OPENING, CLOSING, or STARTING and STOPPING MECHANISM. G P Milnes.
2621 STEAM ENGINES. N Chandler.
2622 VALVE OPERATING MECHANISM. C L Rowland.
2624 WRENCHES. G F Redfern. (*W H Smith*, United States.)
2625 CAR COUPLINGS.* R W Barker. (*The La Burt Electric Block Signal System and Car Coupler Company*, United States.)
2632 ELECTRIC LIGHTING. G R and C A Rollason.
2634 PREVENTING the RADIATION of HEAT. F Trier.
2636 INJECTORS. H H Lake. (*The Serwood Manufacturing Company*, United States.)

7th February, 1893.

2639 APPARATUS for SEPARATING METALS. J A Mays.
2657 FURNACES. E Brook.
2665 REGENERATIVE FURNACES.* R Dietrich.
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2692 CRANES.* E W Naylor.
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2728 VENTILATING SHAFTS. C Ancorn and J Mallett.
2731 CAR COUPLING. D A McCollum.
2735 MOTOR. D H Tuvet.
2740 ELECTRIC ARC LAMPS. J J Rathbone.

8th February, 1893.

2753 AIR-COMPRESSING APPARATUS for SUPPLYING AIR to SMITHS' FIRES and SHIPBUILDERS' and BOILERMAKERS' FURNACES. W Donald and J Donald, jun.
2755 COUPLINGS for BROKEN SHAFTS. A Thomson.
2761 METALLIC PISTONS. N MacBeth.
2763 BRAZED METALLIC TUBES. B Rose.
2764 GIRDERS and OTHER LIKE METAL SECTIONS. P Robinson.
2768 APPARATUS for PRODUCING CHILLED CASTINGS. W Lewis and J Davies.
2770 HYDRAULIC LIFTS. E P J G Licot.
2771 TAPS and VALVES. T Winter.
2772 APPARATUS for ECONOMISING FUEL in STEAM BOILERS. R Harrison and H T Humphreys.
2784 SCREW-DRIVER. J Turner.
2785 GAS ENGINES. E W Evans.
2790 PERMUTATION LOCKS. H H Lake.* (*T Kromer*, Germany.)
2791 PROCESS for the CONTINUOUS PRODUCTION of WATER GAS. F Fanta.
2793 VALVES for CONTROLLING the PASSAGE of FLUIDS. A G Brookes.
2794 TOOL HOLDERS. T W Barber and C C Potter.
2797 GUIDE PULLEY MECHANISM for USE WITH ENDLESS ROPE or CHAIN HAULAGE. H Alty.
2808 VACUUM PUMPS. W S Moore.
2812 PUMPS. W Fuller and C J Bremerkamp.
2815 RAILWAY SHUNTERS.* A J Boult. (*C C E Lesenberg*, Germany.)
2816 LIQUID METERS. W P Thompson. (*G E Samain*, France.)
2817 STEAM BOILER and OTHER FURNACES. W T Smith.
2819 TAPS. J Watkinson.

9th February, 1893.

2832 MINERS' BORING APPARATUS. F Scott.
2836 SCREW PROPELLERS. G Twigden.
2842 FUSIBLE PLUGS for BOILER FURNACES. G Stevenson.
2847 COMPOUND SPRING DEVICE.* G W Gardiner.
2849 METAL SPRING CAGE for THERMOMETER, to PREVENT THERMOMETER from BREAKING. W A Norrish.
2851 GAS and SIMILAR MOTOR ENGINES. A R Bellamy.
2854 RAILWAY SIGNALLING. G H Catt.
2855 SWIVEL UNION for PIPES and TUBES. A Murray.
2857 ANCHORS. E Finch.
2862 GOVERNORS for STEAM ENGINES. H J T Piercy and others.
2872 MOTIVE POWER AUTOMATIC COMPRESSED AIR ENGINE. J C O'Brien.
2886 FEED MECHANISM for PLANING MACHINES. A J Smith.
2888 ELECTRIC FOG SIGNAL. H Brocklehurst and H Constien.
2890 HOT-AIR ENGINES. A J Boult. (*N Brachetti*, Belgium.)
2897 APPARATUS for HEATING BUILDINGS or OTHER PLACES with STEAM. R Dawson.
2904 BEARINGS and BEARING SURFACES. F M Weymouth.
2907 ROTARY ENGINES or PUMPS. F Brackemann.
2910 PREVENTING CORROSION of PROPELLER SHAFTS. W Dumlin.
2912 OIL ENGINES. J E Weyman.
2920 VALVE for STEAM and OTHER POWER ENGINES. W Kerr.

10th February, 1893.

2928 APPARATUS for SUPPLYING AIR to FURNACES. G Knowles and others.
2932 ATTACHMENT for or an ADDITION to LATHES. W Shaw.
2936 HYDRAULIC POWER and WATER ECONOMISER to be APPLIED to RAMS, ELEVATORS, and HOISTS. T Tinker.
2942 SMOKE-CONSUMING APPARATUS. T Lester.
2943 DISTRIBUTING the MOTIVE FORCE and REVERSING FLUID-PRESSURE ENGINES by MEANS of SLIDE VALVES, COMBINED with IMPROVED BALANCE VALVE. J Sharp.
2947 LOCK NUTS for SCREWED BOLTS. J E Steevenson.
2953 METHOD of RAPID CONTROL of SHIPS in CASES of EMERGENCY. J Mumford.
2954 EXTERNAL CAPS for HAND-HOLE COVERS for BOILERS, ETC. J Mills.
2957 PISTONS of PUMPS and SYRINGES. H Turner.
2961 STATION GAS GOVERNORS.* J Hawkyard and J Braddock.
2987 STEAM VACUUM ACID and WATER-TIGHT PACKING of GAUGE GLASSES and OTHER TUBES, ETC.* W Dick.
2995 FRICTION CLUTCHES or POWER TRANSMITTERS. W H Lindsay.
2996 FRICTION CLUTCHES or POWER TRANSMITTERS. W H Lindsay.
2997 WINDING MECHANISM for HOISTS. W H Lindsay.
2998 CLUTCHES or POWER TRANSMITTERS. W H Lindsay.
3011 LIQUID METERS. T Derichs.
3014 STOP VALVES. J A and J Hopkinson.
3015 MITRE and GROOVE-CUTTING MACHINES. G O Goddard and E Brown.

11th February, 1893.

3025 STEAM BOILERS. P Pinckney.
3028 COMPENSATING MOTIONS for USE IN CONNECTION with CRANKS or ECCENTRICS. J Dronsfield.
3036 MECHANISM for AUTOMATIC SIGNALLING on RAILWAYS. J Coombs.
3042 AUTOMATIC SAFETY SIGNALLING APPLIANCES on RAILWAYS. J Howitt.
3045 BORING MACHINES. C F Hotchkiss.
3055 VALVE for CONTROLLING VARIABLE POWER CRANES or LIFTS. C Cornes and W R Green.
3061 EXPANDING PULLEYS. J Walker and J Strang.
3062 STEAM BOILERS. J Mills.
3071 AUTOMATIC ELECTRIC SIGNALLING on RAILWAYS. The Automatic Electric Railway Signal Company Ltd. and E Blakey.

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FRIDAY, MARCH 3RD, 1893.

The Warming of Railway Carriages.

THOSE who are accustomed to travel long journeys in winter know only too well how inadequate are the present means of warming railway carriages; so much so that any improved method should be welcomed by passengers. In this connection it is interesting to note that a system of steam heating, new in the United Kingdom, but which has been in use in the United States for some years, is now being introduced experimentally on two English railways. The system is based upon the use of steam obtained from the boiler of the locomotive and conveyed to storage heaters arranged in each compartment. The steam passes from the locomotive along pipes throughout the train, suitable couplings, similar to those of the compressed air brake, being provided between each carriage. The couplings are, of course, steam-tight, and on the division of a train they are said to uncouple automatically as the carriages are separated. Each of the heaters, one of which is placed under one of the seats of each compartment, comprises two wrought-iron cylinders, one contained within the other. The inner tube is 5ft. long and 4in. in diameter, and is nearly filled with brine and hermetically closed. The outer cylinder or tube is, of course, longer, and of greater diameter. It is in communication with the boiler by means of the steam pipe already mentioned. It will be readily understood that upon steam being admitted to the steam pipe along the train, and therefore into the annular space between the two tubes, the outer cylinder is rapidly heated and the heat commences to radiate in the compartment. Simultaneously with this operation the brine in the inner cylinder begins to absorb heat, which is stored for future use. The supply of steam from the boiler is shut off as soon as the desired temperature in the heater has been attained, and then the heat accumulated in the inner cylinder passes by conduction to the outer cylinder, and from there by radiation into the compartment. It has been found, even with a very low temperature outside the carriage, that the temperature raised in this manner can be maintained for from four or five hours with a diminution of only 3° F. Suitable valves are naturally provided for disposing of the condensed water at the heaters, and for reducing the steam pressure at the boiler. This system is being experimented with on the Great Northern and Manchester, Sheffield and Lincolnshire Railways, and so far the results have been satisfactory. The tests will, we trust, lead to the adoption of the system on those and probably on other lines.

Gas and Electric Light.

IT was pleasant to see that there was nothing but a healthy rivalry between the Liverpool Electric Supply Company and the local gas company, and that not only more gas, but also more electric light was being used. This is the substance of the remarks made last Friday by the chairman of the former company, and in confirming this view a director of the gas company observed that there was a feeling of thankfulness that the electrical company had educated the inhabitants to the requirement of better light, so that more gas was being consumed than formerly. It would be well if this idea were more generally held than is the case. The two companies are working harmoniously in Liverpool with mutually advantageous results. At present some 20,254 incandescent lamps are supplied in that city, as compared with 14,966 a year ago, and applications for further connections to the mains are being received. At the same time, the consumption of gas is on the increase. This is as it should be; and, as pointed out at different times in these columns, the introduction or extension of the electric light proceeds simultaneously with an augmentation in the use of gas, the increase as regards the latter being in the way of heating, cooking, lighting and motive-power purposes; whilst in the case of the former it is present in the direction of lighting, but will ultimately be also in the use of current for motive-power purposes. There is plenty of room for both electricity and gas, and if this were more readily understood there would be fewer reflections cast upon a growing industry at the meetings of gas companies.

The Iron and Steel Industry of the United States.

THE progress of the iron and steel industries of the United States during the last twenty years is the subject of an official report of the American Iron and Steel Association, which has lately been published by the Department of the Interior. The production of iron ore has risen from 3,031,891 tons in 1870 to 14,591,178 tons in 1891. The average annual imports of iron ore during the last twelve years were only 719,300 tons. From the tables given, it is evident that the United States is the greatest producer of iron ore in the world, and is therefore more independent of foreign sources than any of the chief iron-making countries. Moreover, the supply for the future promises to be practically inexhaustible. There is, however, a scarcity of Bessemer ores on the Atlantic coast, and the imports are chiefly to supply this want. The Lake Superior ore fields give 56 per cent. of the total, the next in importance being the Cornwall ore district in Pennsylvania, which has been worked since 1740. The production of pig iron increased from 2,546,713 tons in 1872 to 9,157,000 tons last year. Twenty years ago it was little more than a third of that of Great Britain; but it has grown so steadily and rapidly that now the United States is the largest producer in the world. The production for 1891 in Great Britian and the United States was 7,406,064 and 8,279,870 tons respectively. In 1887—prior to which year the statistics were not kept separately—the production of Bessemer pig iron was 3,220,517 tons in a total production of 7,187,206 tons. In 1890 the former total had increased to 4,583,424 tons. The manufacture of steel has also increased rapidly in the United States. In 1860 the total production was 11,838 tons only; in 1890 it had reached 4,277,071 tons. Between 1872 and 1891 the production of Bessemer steel had increased from 120,108 tons to 3,657,107 tons, of open-hearth steel from 3000 to 649,323 tons, and the total of all kinds of steel from 160,108 to 4,372,749 tons. Up to 1883 Great Britain was the leading steel-producing country in the world; but in that year the United States took the first place. The great growth in the steel-rail industry is due to the extraordinary increase in railway development in the United States.

The Forthcoming Building Exhibition.

WITH the exception of the Smithfield Club Show and the Brewers' Exhibition, trade exhibitions at the Royal Agricultural Hall, London, have become to be regarded of secondary importance. Almost empty halls or absence of "gate" or business has not induced manufacturers to largely participate in trade exhibitions. A fairly good show was, however, made last year at the Building Exhibition, and the tenth display of this kind will open on the 11th inst. and close on the 25th inst. This exhibition, promoted by Mr. J. Black, of 2, Newcastle-street, Strand, London, comprises architecture, engineering, construction, decoration, furniture, and all industries connected with the building trades. The exhibition, which is the eleventh of its kind, deserves to be better than its predecessors.

Electric Railways.

FOLLOWING his paper read before the Institution of Civil Engineers on "Electrical Railways," an abstract of which was given in our last issue, Dr. E. Hopkinson lectured on the same subject last Friday before the Royal Institution. He referred to the first experimental electric tramway, shown at Berlin in 1879, and to that at the Paris Exhibition in 1881. Very few who saw the latter would have ventured to predict that in ten years' time over 5000 electric cars would be in operation in the United States alone, or that electric traction would have solved the problem of better communication in London and other large cities. Passing on to the production and distribution of electric power and its reconversion into mechanical power, the lecturer mentioned that in Scotland and Ireland there was abundant water-power which was now only partially utilised. The Portrush, Bessbrook, and Newry and City and South London lines were next considered. With regard to the use of the rails for the return circuit, he expressed the opinion that it appeared probable that the use of the earth for the return would, in the more or less distant future, be guarded by legislation. Unless worked at enormous speed, he thought that trunk lines could not be operated electrically, but electric traction had a great future before it for working such underground lines as were projected in London, Paris, Berlin, Brussels, and other cities. The high speeds proposed of from 150 to 200 miles an hour could be realised by the purely rotary motion of an electric motor, whilst with a steam locomotive such rates were probably unattainable. There seems much truth in this statement; but we fancy that Dr. Hopkinson made a little joke at the expense of those who advocate "through journeys by lightning" when, if correctly reported, he mentioned that "with the electric motor a speed of 1000 miles an hour could be obtained, and they could do greater things still, though beyond that point they perhaps entered the region of projectiles rather than of locomotives."

Signalling between Vessels.

AS a means of signalling between vessels at sea, the telephote is suggested as being superior to flags or signal lights. The signals of the telephote correspond with the Morse alphabet, and can be reproduced by flashes of light by means of incandescent lights arranged upon a signal mast. The transmitting apparatus, which can be located in any convenient place on board ship, comprises a keyboard having 37 letters, figures, etc., and is contained in an aluminium box. The wires from this keyboard are formed outside the box into a cable, which is led to the signal mast. This mast is made in three parts, the central section being capable of sliding half inside the lower part, whilst the upper section slides down over the other half of the middle part. When extended to its full length the mast is 27ft. long, and 9ft. when collapsed. The mast is provided with 106 32C.P. lamps, which, when any key of the transmitter is depressed, are caused to form combinations so as to reproduce the Morse code. The signals can be produced horizontally by placing the mast in a horizontal position. By transposing the letters on the keyboard, it is possible to utilise the transmitter for secret signalling. The telephote permits of 72 letters being transmitted per minute, and the signals can, it is said, be seen at a distance of ten miles at night. We assume that the lamps would be placed inside clear, or rather frosted glass protectors. At all events, the general arrangement, if not complicated, must be very delicate, considering the number of lamps proposed to be used.

A Feed-water Filter.

THE collapsing of furnaces and the burning of boiler plates is, as is well known, due in a large measure to the oil or grease which is carried in with the feed water, and which deposit forms a remarkably good non-conductor of heat. The way in which the globules of oil combine with small particles of calcic sulphate and other solids has been very ably described by Professor V. Lewes, in his paper on "Boiler Deposits," read before the Institution of Naval Architects, and which will be found in our issues for April 4 and 11, 1891. As a means of preventing this deleterious deposit, a filter has been introduced which has been found to very effectually fulfil this object, and which is being manufactured by Messrs. Maudslay, Sons and Field, the well-known marine engineers. This filter consists of a metallic chamber or filter box, in which are a series of gratings, and between these gratings are placed layers of wire gauze and flannel of a special texture, which forms the filtering medium. The feed water from the donkey pump enters the filter box on one side, passes upward through the filter cloths and thence out to the boiler, the scum passing away through another outlet. By this means it is found in practice that all grease and greasy matter, as well as other impurities, are arrested by the filter cloths, which can be readily taken out for cleansing or renewal. This further means a reduction of scale in the boiler and improved steam-raising power as an additional means of preventing corrosion. Although only of recent introduction, we understand the filter has already been supplied to a large number of vessels.

IT is stated that an American electrical company has just constructed a machine for polishing and giving a gloss to the nap of hats. It is a small electric motor, on which the hat to be treated is mounted and fixed, and the axis of the motor gives it a quick rotatory motion. It is then sufficient to keep against the hat a band of wool or felt, and in a very short time, owing to the heat caused by the friction, the desired end is attained.

Machine Construction.

THE CONSTRUCTION OF MACHINE ELEMENTS.

(*Continued from page* 42.)

§ 157.

FRICTION CLUTCHES.

COUPLINGS in which one portion transmits motion to the other portion by means of friction are often especially applicable, since by the mere removal of the frictional contact the parts are disconnected, and when they are thrown into contact the driven portion is put into motion gradually. By making friction couplings of large diameter, they may be used to transmit proportionally great rotative moments. In Fig. 445 is shown a friction coupling used by Ramsbottom in rolling-mill work.*

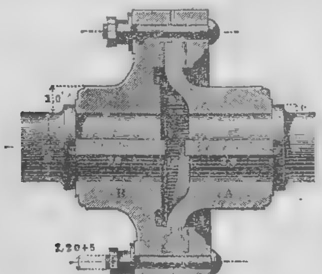
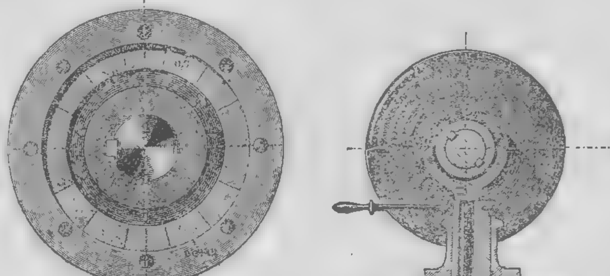


FIG. 445.



MACHINE CONSTRUCTION.

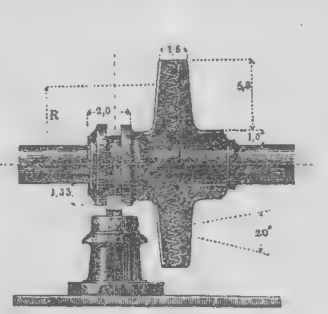


FIG. 447.

The part A is firmly clamped between the wood-lined surfaces of B; but the parts may be arranged so as to slip if undue resistance is encountered, thus making it a safety coupling. The modulus as before is

$$\delta = \frac{d}{3} + \frac{3\text{in.}}{16}.$$

Cone couplings are used also in many forms. In the example shown in Fig. 446 the driven portion A of the coupling carries a gear wheel shown in the dotted lines, to which motion is to be transmitted from the shaft. The two parts are forced into engagement by the screw and hand wheel b. If the parts are so arranged that the motion of the hand wheel b is in the same direction as the rotation of the part B, when the latter is thrown into engagement it is only necessary to hold the wheel b stationary in order to throw the clutch out of gear. From the mean radius R of the cone surface, and the angle or taper a, we have for an axial pressure Q, for any circumferential force P :—

$$Q = P\left(\frac{\sin a}{f} + \cos a\right)$$

$$= \frac{(P\,R)}{R}\left(\frac{\sin a}{f} + \cos a\right) \ldots (146)$$

in which f is the coefficient of friction between the cone surfaces, and (P R) is the statical moment tending to rotate the shaft. The angle a should not be taken at less than 10°, in order that the parts may not become wedged together; for iron on iron, f may be taken at 0·15. In order to keep both P and Q as small as possible, R should be made large—say, between 3 and 6 d.

The relative motion of the screw and hand wheel is, of course, dependent upon the radius of the wheel b, and upon the pitch s of the thread.

Example.—A wrought-iron shaft of a diameter d = 2in., making 50 revolutions per minute, would transmit, according to the table of § 145, 0·1313 × 50 = 1 5 H.P., or have a statical moment P R = 1975in.-lb. If the radius of the friction cone couple is equal to 5 d, or 10in., we have according to (147)

$$Q = \frac{1975}{10}\left(\frac{\sin a}{f} + \cos a\right).$$

If a = 10°, and f = 0·15 we have

$$Q = 197{\cdot}5\left(\frac{0{\cdot}1736}{0{\cdot}15} + 0{\cdot}9848\right) = 423\text{lb.}$$

Suppose the hand wheel to have a radius of 4in. and the screw a pitch of ¼in., we then have for the force to be exerted on the rim of the hand wheel:

$$q = \frac{0\,25 \times 423}{\pi \times 4} = 8\,4\text{lb.}$$

For the transmission of moderate force the cone coupling, or some of its various modifications, has very generally been used.† Instead of a single pair of external and internal cones, a number of small elements may be employed. This form is shown in Fig. 447. The general calculations are made as above, except that the lever arm R of the friction must be reduced, and may be taken with sufficient accuracy at a point distant from the outer circumference equal to one-third the width of the grooved frictional surface. The operating lever in this case need make but very little movement, and the arrangement of a fork mounted on an eccentric bearing as shown in the illustration, may be conveniently adopted.‡

When a cone coupling is intended to be used for the transmission of large forces, the apparatus for pressing the parts together may sometimes be so arranged that it is mounted on the shaft, revolving with it, without creating so much pressure against the bearing. The fork and grooved collar shown in Fig. 447 is not suitable for heavy clutches, on account of the excessive collar friction; hence the pressure is better applied by means of a screw mounted on one of the shafts, and this may be conveniently arranged so as to draw both shafts firmly together. Suppose the shaft to be 4in. in diameter, we have from the preceding, R = 6 d = 24in., and an axial pressure

$$Q = \frac{31{,}600}{24}\left(\frac{0{\cdot}1736}{0{\cdot}15} + 0{\cdot}9848\right) = 2818\text{lb.}$$

This endlong pressure, instead of creating hurtful collar resistance, may be utilised by arranging the parts as shown in Fig. 448, which shows a friction clutch coupling of the author's design. As shown in the section, the part A extends over the part B, and both parts are drawn together by the action of the screw and hand wheel. The only modification in the screw gear is that the screw is made large enough to permit the shaft to be passed through it, the thread being thus cut upon the hub of the part A. This coupling runs very smoothly. The concentric channels should be arranged with clearance at the bottoms of the grooves, as shown in the section, to provide for fitting and wear. The modulus for the parts is the same as before—viz., $\delta = \frac{d}{3} + \frac{3\text{in.}}{16}$.

(To be continued.)

* See "Engineer," 1866, January, p. 44; also "Genie Industrielle," vol. 32, p. 101; and an older form of this coupling is shown in Salzenberg. "Vortr.," p. 173.

† Many such applications will be found in the description of the Suez Canal. See Armengaud, "Publ. Ind.," vol. 17, pl. 9.

‡ See Armengaud, "Vignole des Mecaniciens," plate II.

Metal-cutting Tools.

(*Continued from page* 34.)

The Machine Reamer.—As the standard reamer should never, under any circumstances, be used otherwise than by hand, it is necessary to provide a tool for use in lathe and drilling machine; and for this purpose we have the chuck, or more properly the machine reamer. The proper function of this tool is what might be termed preparatory—that is, it should be used after the drill, or drills, to bring the holes to an approximately uniform size, and to take out any inequalities left by the drill. For accurate work it should leave the hole enough smaller than the finished size to allow for a proper cut with the standard hand reamer. As the machine reamer will almost invariably cut larger than itself, and also make the hole slightly taper, this fact must be provided for in the original size to which it is ground. It will also cut different sizes on different materials, and whether used with or without oil. Furthermore, as the amount of stock necessarily left for its cut is comparatively large, it becomes dulled and the size correspondingly decreased much more rapidly than the hand reamer. For these reasons it is obviously unsafe to depend on this tool for finishing, except for rough work, where duplication is unnecessary. While in a general way it is similar to the hand reamer, it differs as to size and the amount of edge clearance allowable. Being firmly held to the work, and the motion of reamer or work, as the case may be, being perfectly steady and the feed perfectly under control, the clearance may be much greater without causing any tendency to chatter. It may, therefore, be ground with a fine wheel by placing on the index centres of grinding machine. If done by a wheel whose axis of revolution is parallel with that of the reamer, the former should be of as large diameter as possible, as otherwise the clearance would be hollow-ground, which would greatly increase the angle at the expense of durability and efficiency of the tool. Much the best method of clearance grinding is that in which the wheel is set with its plane of rotation parallel with that of the reamer. This will obviate the curvature of the other method and enable the operator to know exactly the angle and amount of clearance he is giving the tool. The amount of taper at the point should be considerably greater than that of the hand reamer to enable it to enter the hole without difficulty, even if the amount of stock to be removed is comparatively large.

In both of these tools—in fact, any straight-fluted reamer—the size is necessarily decreased continually by use by reason of the wear of the cutting edges. It therefore becomes necessary, after the reduction reaches an objectionable amount, to restore them to their original size. This may be done repeatedly if the quality of steel be such as not to suffer deterioration by the continual hardening and annealing required each time the tool is dressed. The operation, of course, is simply setting out the teeth; and a method, probably as good as any, is, after carefully annealing, to place the reamer on the lathe centres, and, after screwing up tightly, wedge the carrier in the faceplate slot and lock the back gears. This will hold the work firmly in position, and it can be indexed around by the gears as required to bring the teeth successively in the most convenient position for the operation. The tool used should be a narrow set, having the end carefully finished, perfectly smooth and true, and the lower corner slightly rounded off. The thickness of edge should be a little greater than the depth of grooves in reamer, so as to cover the entire edge. Guiding the set by resting the hand along the body of the reamer, it should be tapped with a light, quick blow, moving it about ½in. each time the entire length of the groove. After going over the tooth this way once it is best to proceed with the next, and so on until all have been subjected to the same treatment, after which the size may be calipered, and if the size is found to be insufficient to allow of ample stock to ensure its finishing up properly, it will be necessary to go over it again in the same manner. This will generally suffice, unless the reamer has been reduced more than is allowable. The operation of setting, says a writer in the "Iron Age," is very simple, but requires careful work to accomplish it properly. The subsequent operations of hardening, tempering, and grinding are, of course, the same as for a new tool.

The Shell Reamer.—The shell reamer is simply a hollow cylindrical form, made to use on a mandrel or bar. It is generally used for sizes which would be inconveniently heavy and unwieldy if made in the form of the ordinary solid reamer, which would also be unnecessarily expensive. They are used for both standard and machine use, and are precisely the same as to construction and use as the respective solid patterns.

Other forms of straight reamer are the adjustable and the expanding types. The former are very similar in appearance to the solid reamer, but they are made with detachable and adjustable teeth set in the permanent stock or body. There are several forms of this tool, having different methods of adjustment, but the one most commonly used is made with seats for the teeth planed with the body set taper from neck to point. The teeth, of course, have a corresponding taper, and by driving up from the point, the size may be increased, or *vice versâ*. In some shops, where this form of reamer is preferred, the stocks are very carefully made and the grooves finished after the body has been hardened and tempered. This gives them increased durability, and should render them good for wearing out many sets of teeth. The size of such reamer should never be permitted to be altered outside of the tool room, as an irresponsible and incompetent workman might cause the spoiling of not only his own work, but also that of others who might afterwards use the tool before the error of adjustment was discovered. The original and only legitimate object of the device was to provide a more simple and inexpensive method of keeping the size than is possible where the solid tool is used. If used in this way and for this purpose only, the adjustable reamer is a good tool, otherwise it is a very dangerous one. For standard, at least, it should never be used after setting out until it has been reground and cleared; for machine use, or rough work, the risk is not so great, but still it is a bad plan to take any unnecessary chances.

The Expansion Reamer.—The expansion reamer, like the expansion centre bit, is a sort of *multum in parvo*, and is intended for use for any desired size between its maximum and minimum limits. Of course, for straight work, the expansion must be perfectly parallel, and the tool very accurately and carefully made, or it will be worse than useless. The teeth are made taper on their inner edge, and are carried in a hollow body or shell, where they bear against a tapered mandrel or core, which is adjusted longitudinally by means of a screw motion. For many purposes the tool is a very useful one, and, in job shops, where there is a large variety of miscellaneous work, it will always "pay for its keep." They are also made for taper work where a greater range of size is desired than can be had with the ordinary solid form. The latter and all special shapes of fluted reamers should be made similar to the straight with reference to construction of the teeth, but as they are required to remove considerable stock in giving form to the roughly-drilled hole, more edge clearance is required to enable them to work rapidly. Care must be taken, however, not to exaggerate this feature, or they will give continual trouble from catching, and cause risk of breaking themselves or the work, whichever be the weaker. Slow feed, careful feeding, and frequent withdrawals to clean out the chips, are necessary to the successful use of these tools, no matter how correctly they are made. Flat,

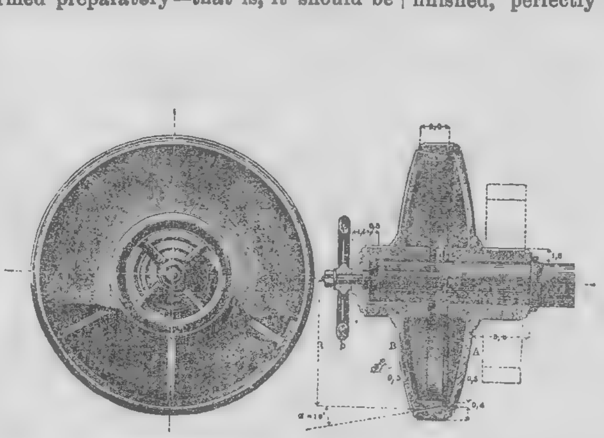


FIG. 446.

MACHINE CONSTRUCTION.

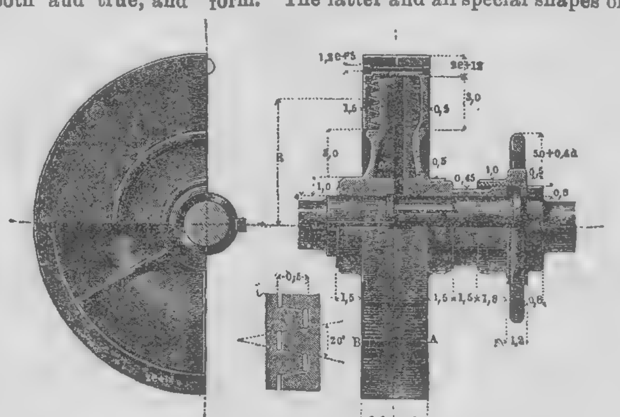


FIG. 448.

half-round and square, taper and shape reamers are also used. The first two are very good for some classes of work; the latter is an abomination, as violating all correct principles of metal cutting, and should never be used, except as a make-shift when nothing else is available.

(*To be continued.*)

Variable-speed Power Transmission.

IF such an estimate could be made with any approach to exactness, it would be most interesting to know how many pairs of step pulleys are to-day in operation in the United States alone. Surely there are few mechanical contrivances more generally accepted and incorporated into every class of machinery for affording a simple and ready means of changing the speed either of the entire driven mechanism or of one

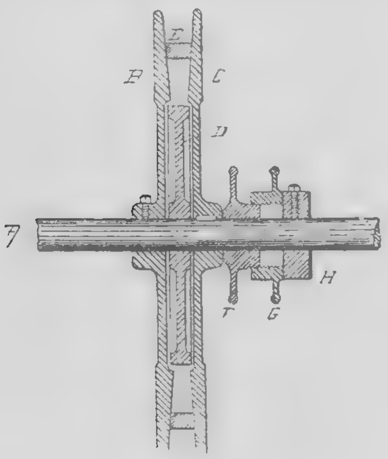


FIG. 1.

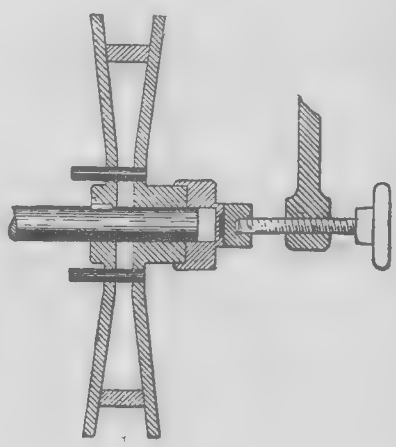


FIG. 2.

or more parts of it, independently of others. Yet their inherent defects are so well known as to call for hardly more than bare mention, in order that they may be borne in mind while considering the device presented below. Inability to produce speeds other than those predetermined by the ratios of corresponding steps; the limited number of such speeds except as obtained by large and unwieldy cones with an excessive number of radii, at a corresponding expense in stock and finishing cost; inconvenience of shipping belts except as applied to light work and without stopping the machine, or at least depriving it of driving power while the change is being made; enforced parallelism of driving and driven shafts;—all are considerations so thoroughly appreciated by practical engineers and designers as to

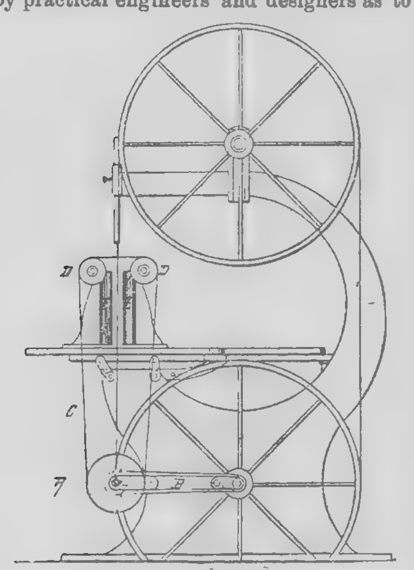


FIG. 3.

call for no extended comment. The demand for something which should offer the same advantages with fewer attendant drawbacks has been partially met by a number of devices which have become more or less well known in connection with various classes of machinery.

In spinning apparatus, speeders and fly-frames allow the use of continuous element cones, the shafts being conveniently placed near together and parallel, while a continuous and gradual change of speed is obtained by slowly and automatically shifting the belt from one end of the cones to the other. Were the required range of speed greater, however, or the change more rapid, the device would evidently not produce such satisfactory results.

In wood-working machinery the use of a wheel so arranged that it may traverse a driving disc, its edge thus attaining a speed corresponding to that of the disc at varying distances from its centre, has been tried with more or less success, but the frictional contact (theoretically a line only) is so slight that sawdust, or dirt of any kind, on wheel or disc, is liable to interfere with uniform action, while the axis pressure of both parts must be excessive, and the driven shaft varies its position with every change of speed, necessitating an extra link in the mechanical transmission, with a consequent friction loss.

The Evans friction cone has recently been applied to a number of problems of this character, but is open to the objections inherent in all continuous cones, while the shafts must be close together, and expert opinions differ as to the durability of the belting used, owing to the peculiar and rapidly recurring stresses to which it is subjected when in operation.

Without dwelling upon other devices for obtaining the desired results, we come to a type of apparatus which seems to the writer to overcome most of the difficulties noted, in a simple and effective manner, the invention of Mr. E. F. Gordon, mechanical engineer of the John A. White Company, of Dover, N.H. In the opinion of those most interested in its development, it is worthy of more extensive trial and investigation than has been, or can in the immediate future be, given it in the line of machinery to which it is now being applied, and in presenting it to the society it is hoped that its possibilities and limitations will thereby be more clearly brought out by actual demonstration.

Simply stated, the device consists of a deeply-grooved pulley, split by a plane perpendicular to its axis, and dividing it symmetrically, with means for varying the distance of the two parts one from the other.

Given a belt adapted for the purpose, it will, in running on such a pulley, lie nearer the centre as the two parts are more widely separated, and recede as they are brought nearer together. Such a pulley may be used on either the driving or driven shaft, or both, and it is evident that the shafts may be at any practical distance apart; also, that the greater the pull on the belt, the greater its hug and consequent freedom from slip. In some cases it is desirable to place a loose pulley between the two parts referred to, making a compact arrangement for starting, stopping, and varying speed, in the space ordinarily occupied by a single pulley of the usual style.

Fig. 1 shows such an adaptation of the device, with one of the many available arrangements for varying the working radius of the pulley. In the illustration, A is the shaft, B C the two halves of the pulley, D the idler, E the belt, F G hand wheels, H a collar fast on the shaft. By the action of the belt, B and C tend to separate from each other, and since B is fast on the shaft A C, which is splined on the shaft, and hence must turn with it although free to move along it, it is forced against F. The hand wheels F and G are free to turn on the shaft, but may be held at rest whenever desired. The hub of one carries a male screw, and the other a female, so that by altering the position of one on the other they increase or decrease the distance between the collar H and the half of the pulley C, thereby allowing C to recede to a greater or less distance from B, and determining the position of the belt E and its consequent speed relative to that of the shaft A. It will be evident that in this construction, when used as a driving shaft, the belt speed will become less and less as F is screwed into C, until C has so far receded from B as to allow the belt to drop on the idler D, when the driven mechanism will come to a standstill, to be gradually started again by the adjustment of F and G.

Fig. 2 shows a still simpler form, applicable when the pulley is located on the end of a shaft. In this case the loose pulley is omitted, it being assumed that only a speed adjustment is necessary, one part of the pulley being fast on the shaft, the other free, but loosely pinned to the first so as to rotate with it, the working being determined by the adjustment of a hand screw.

The belt may be either round or nearly square in section, though for most of the experiments so far made a narrow double-ply leather belt has been used, with the edge bevelled to correspond with the angle of the pulley face.

The construction shown in Fig. 2 has recently been applied to the feeding rolls of a 48in. band-resawing machine, in a way which illustrates its simplicity and adaptation to this class of work.

Fig. 3 shows the arrangement of parts, A being the split pulley, its shaft being driven by a link belt from a continuation of the lower band-wheel shaft, and supported by an arm B swinging from this as a centre. The belt C drives the pulleys D D on horizontal shafts worm-geared to the axes of the feed rolls, the swing of the arm B compensating for the varying length of the belt C, owing to changes either in position of the feed rolls E with reference to the saw, or in the working radius of A, the latter being determined by the position of a hand screw.

The diameter of the split pulley is 12in., the minimum working radius 3in., giving a linear speed to the surface of the feed rolls of from 10 to 30 per minute. A double-ply belt 1in. wide is used, and its power is such that if the stock be held firm the slip occurs between it and the feed rolls (four in number, all geared, 18in. long, 3in. diameter), and not at the belt, as in the case of the usual style cone pulley formerly used with a machine of the same capacity.

No dynamometric tests have yet been made, but a pulley 6ft. in diameter is now nearly ready for careful investigation as to efficiency under widely varying loads and speeds. Should the results be satisfactory, the simplicity, compactness, reliability and cheapness of the device would apparently warrant its extensive use by the engineering fraternity.

* By H. C. Spaulding, in Transactions of American Society of Engineers.

American Friction Clutches.

A MEETING of the Engineering Section of the Bristol Naturalists' Society was held on February 21 at the Bristol University College, Mr. J. W. Harvey (president) in the chair. Mr. Thomas Morgans read a paper on "Some American Friction Pulleys and Clutches." He stated that frictional connections of these kinds were much more widely used in the United States than in this country, where either fast-and-loose pulleys or claw clutches (the latter usually demanding a slowing down of speed) were more in favour. The fact, however, that the disengagement and stoppage of a friction pulley also stopped the running of the belt was in some cases a marked advantage, because where workmen had to operate near a running loose pulley, they required to be constantly mindful of keeping clear of both it and the belt. Two forms of friction pulley (one of which is extensively used in the United States) and one form of friction clutch were described, and it was shown that some of their details evinced considerable mechanical skill and contrivance. A novelty in one of the pulleys was that it possessed no eye or boss, and when at rest had no connection whatever with the shaft passing through it. A fractured specimen of a so-called cast steel was exhibited. This material had been found to be both very strong and very tough, and for some uses was being substituted for malleable cast iron. It was being made on a large scale by a firm of manufacturing engineers of high repute, who produced it by charging to the foundry cupola a proportion of best scrap steel with the usual mixture of scrap and pig iron.

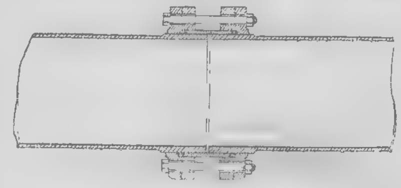
After a discussion, in which Messrs. H. W. Pearson, W. Thomson, W. G. Walker, N. Watts, and others took part, a vote of thanks was accorded to Mr. Morgans for his interesting and practical paper.

IT is announced from Lyons that MM. Gouttes and Sibillot have made experiments with the view of adopting aluminium as the material for the gasholders of dirigible balloons instead of silk or other stuffs, with satisfactory results.

The Transmission of Power by Compressed Air.

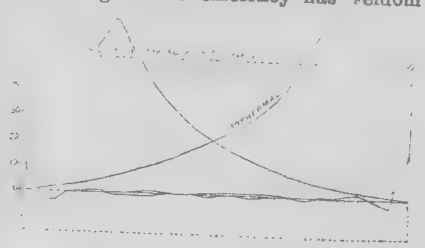
(*Concluded from page 57.*)

IT has been claimed that the straight-line air compressor has a mechanical efficiency of 95 per cent., and that the loss due to heat has been found to be in certain



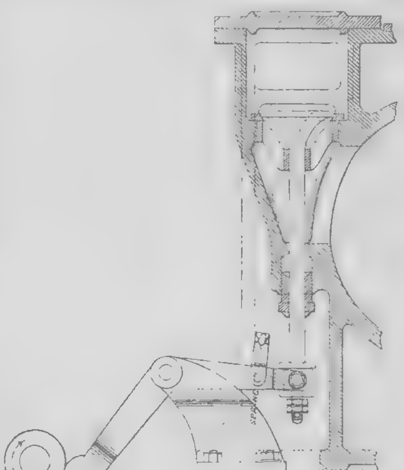
JOINT FOR MAINS.

cases as low as 3·6 per cent.; but much depends upon the way in which the efficiency is calculated and the number of indicator diagrams from which the average is taken. It is a significant fact that in almost all cases where it has been possible to measure the brake horse-power of a steam engine the efficiency has seldom



reached 90 per cent., although 94 and 95 per cent. are becoming common figures, when the estimate is based upon friction diagrams.

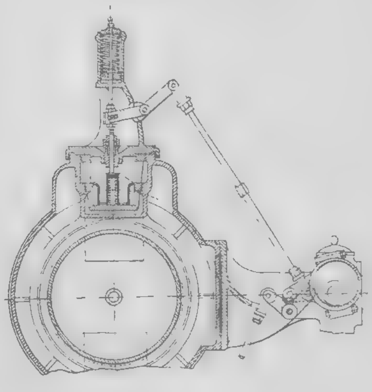
Comparing the above efficiencies with those of the electrical method, I think we may reasonably claim that the engine and shafting efficiencies will not be greatly



DELIVERY VALVE WORKED BY CAM.

different from 87 per cent., while the commercial efficiency of a dynamo seldom exceeds 90 per cent.; the total efficiency, therefore, in this case will be this: That for every 100H.P. indicated in the steam engine, the corresponding electrical H.P. at the terminals of the dynamo will be

$$\frac{87 \times 90}{100} = 78{\cdot}3\text{H.P.},$$



RIEDLER-PROELL DELIVERY VALVE.

so that there is not a very material difference between the two systems so far.

True it is that such a comparison could not have been made some years ago; but it should not be forgotten that progress is being made in all directions, and those who are engaged in one branch of engineering should be careful, when making comparisons, not to take the most modern results

in their own branch and compare them with ten-year-old results in another. Ten years ago it would have been a remarkable circumstance if an efficiency of 50 per cent. could have been produced by an air compressor when measured in the manner just spoken of.

So far, then, we have dealt with the compressor, and have given considerable attention to it because of the vital effect it has upon the economy of the system.

The mains are the next subject for consideration, and the cause of loss in them is two-fold: First, there is the loss of air from escapes at joints and faulty places, or what may be called the loss from untightness. Second, there is the loss from friction in the mains.

As regards the first item, it depends very much upon the care taken in making the joints; but there is a great unanimity of opinion among writers on the subject that this loss in ordinary cases is very small. The question of jointing the pipes is so important that it seems almost incredible that mains should be laid in the ground and covered for good, when it was known that small leaks existed in almost every length. Yet, if current rumours are true, such was the case in at least one very important installation. Gas engineers are fully aware of the great importance of making their mains tight, and of the saving which results from having sound work in them; but they experience considerable yearly loss on account of having to keep mains charged with gas throughout the year, while for seven or eight months of the year comparatively little gas is being supplied. Under such conditions it is easy to see that a very small leakage soon becomes a perceptible percentage of the volume supplied, whereas if the mains were delivering the full capacity throughout the whole time, the leakage would be a vanishing quantity. Breakages also often occur owing to the too rigid nature of the joints, which do not allow the pipes to give when any settlement of the ground takes place. While the joint should be firm and tight, it should also possess considerable flexibility in any transverse direction, and the material used for making the joint should be yielding, yet not subject to deteriorate from contact with air.

Flanged joints for any but service connections should not be used, though they are the simplest and tightest form of joint; and the jointing material should not be of indiarubber, unless of such a quality as to withstand the action of oil. The writer knows of several cases where great loss was experienced from leakage owing to the rubber joint rings becoming softened by oil carried over with the air from the cylinders.

The joint which appears to have given the greatest satisfaction in large installations is of the kind shown in figure, the rings being made of rubber specially prepared to resist the action of oil. This joint has considerable flexibility, and is easily made. All pipes of large size should be made of wrought iron or steel, and not of cast iron, because of the danger of breakages.

The only considerable tests of the tightness of air mains are those carried out upon the Paris system, by Professors Riedler and Gutermuth. They were able to test one length of 11·8in. main 5·78 miles long, one length 10·66 miles long, and various shorter lengths, and their conclusion is that the leakage is very small. There were about 31 miles of mains laid at the time of the test.

Taking average results from six tests of varying lengths, we find that there is a loss of about 4100 cub. ft. per mile (taken at atmospheric volume), or equal to 0·38 per cent. of the total hourly volume supplied. This volume is given as 1,065,000 cub. ft. (reduced to atmospheric volume), but if that is so it seems reasonable to suppose that the main is supplied from both ends—the drawings appear to show this also,—for if one main only supplied that volume the velocity would be over 61ft. per second, which is much too high for economy. Assuming, therefore, that the main is designed to carry half that quantity, we should arrive at the result that the loss from leakage would be 0·76 per cent. per mile of the total carrying capacity of the main. The "load factor" of the installation is about 40 per cent., I believe—that is to say, the actual turnout for a year is 40 per cent. of what it would be if the whole of the plant worked at its maximum for every hour in the year. Consequently, the yearly loss due to leakages would be practically 2 per cent. per mile.

With reasonable velocities—say up to 40ft. per second—of air through the mains, the frictional loss is not great. It varies with the diameter of the main, the velocity of the flow, and the coefficient of friction, in the manner shown by the equation (due to Professor Unwin), and for a pipe 1ft. in diameter and a velocity of 40ft. per second, as a maximum, the loss of pressure in a five-mile length would be about 25lb., assuming the absolute initial pressure to be 100lb. per square inch.

The final portion of our subject is that referring to the motors, and in dealing with it I cannot too firmly press upon you the importance of arranging these in such a way as to render possible the using of the air expansively. It has been the custom to use compressed air in the most expensive way—that is to say, with practically no expansion. This custom arose from the well-known difficulty of the freezing up of the exhaust ports of the engine when considerable expansion was attempted, while with small grades of expansion, such as that given with a cut-off at three-fourths of the stroke, the difficulty was not great unless the weather was very cold and frosty. But if the compressed air is quite dry and is suddenly expanded from, say, 100lb. per square inch to atmospheric pressure, even by opening a valve in a pipe and blowing the air away into the atmosphere quite sufficient degree of cold is produced to cause freezing. In order to make this clearer, it will be necessary to consider the condition of the air before compression, during compression, and after expansion to atmospheric pressure.

Consider, then, the state of 1lb. weight of air before compression—that is, at the atmospheric pressure and temperature, which we will assume to be 14·7lb. per square inch, and 60° F. This air will occupy a volume of 13·09 cub. ft. if dry, but if saturated with moisture the mixture will occupy 12·9 cub. ft. It is a similar mixture with which we always have to deal, though as a rule the air is not perfectly saturated, but contains sufficient aqueous vapour to make 12·95 cub. ft. weigh 1lb. In other words, each pound of the mixture consists of 6948 grains of air and 52 grains of aqueous vapour. The law of saturation is this:—That the same weight of vapour saturates the same space, providing the temperature is constant, irrespective of the pressure, so that when compression takes place water would be deposited if an increase in temperature did not occur. Supposing the mixture to be compressed into one-seventh of the space it originally occupied, the amount of water which would be deposited during isothermal compression would be

$$52 \text{ grains} - \frac{5{\cdot}77 \times 12{\cdot}95}{7} = 41{\cdot}326 \text{ grains.}$$

But as the temperature is not constant during the compression, if any water is deposited near the commencement of the action it is rapidly reabsorbed as the temperature increases, for the weight of vapour which will saturate a space of 1 cub. ft. at a temperature of 60° F. is 5·77 grains, whereas if the temperature is 100° F. the weight of the vapour would be 19·48 grains.

Now the effect of the presence of vapour in the air under compression is to reduce the final temperature, because the specific heat of the vapour is about 0·478, or double that of the air, which is 0·2377; hence the compression of saturated air is slightly more economical than that of dry air.

Assuming now that the pound of air mixture under observation has been delivered into the mains at the final temperature of compression, we shall notice that it immediately begins to cool from radiation and conduction through the material of the pipes, and it quickly arrives at a temperature at which it will be saturated. As soon as this point is reached any further fall will be accompanied by a deposition of water in the pipes, and when the atmospheric temperature is again reached, 41·326 grains of water will have been deposited.

It frequently happens that this water is not separated from the air, but is carried forward along the mains to the motors, and under the old system of using the air without reheating, it is the fruitful cause of freezing up the passages when the temperature falls owing to the performance of work. Before following the air in its action upon the motor it will be well to point out that the whole of the power spent in compressing it has been dissipated into the atmosphere in the form of heat as soon as the temperature of the compressed air in the mains has fallen to the temperature of the atmosphere, for the total energy contained in one pound of air is the same at all pressures if the temperature is the same; this is the reason why a fall of temperature takes place during expansion.

When the compressed air is admitted to the cylinder of the motor a certain portion of the stroke is performed at full pressure, and the work so done causes no fall in temperature, for it is not drawn from the energy in the air, but is done by the compressor much in the same way as if the air between it and the motor were a solid rod. Cut-off now takes places, and any further work must be done by expansion of the air, and the equivalent heat-energy will be drawn from the air and the moisture mixed with it. The effect of the moisture will now be to retard the fall of temperature, in the first place because of the difference in specific heats of itself and the air, and, secondly, as soon as it commences to deposit in the form of water, from the latent heat necessary to hold it in the form of vapour. These actions have a very important effect upon the final exhaust temperature.

The whole trouble of freezing has often been overcome by spraying a considerable quantity of water into the cylinders of motors which run at a speed where water can be used with safety. But freezing also occurs in such machines as direct-acting pumps working with compressed air and having practically no cut-off at all. This is due to another cause of equal importance. Many books have been written in which the statement is made that if the air is used with practically no expansion there will be no trouble from freezing. Such a statement is quite untrue when applied to all sizes of machines.

The reason of the freezing is this: Take the case in which there is actually no expansion in the cylinder at all. When the exhaust port opens, the air inside and out will be at atmospheric temperature, but the air inside is at, say, 7 atmospheres pressure. Sudden expansion therefore occurs, and a great deal of work has to be done by the high-pressure air in forcing the atmosphere back to make room for itself; the result is a considerable fall of temperature near the exhaust port, and if the size of the machine is considerable the temperature of the metal round the exhaust port will fall below the freezing point, and ice will form.

In such cases the maximum efficiency of the whole transmission does not exceed 30 per cent., while it is much more usual to find an efficiency of 12 to 15 per cent.; and it is only in places where any form of heater would be dangerous, or where the amount of air required is very small, that such an arrangement should be used.

To render the system highly economical it is necessary to use expansion, and to do so carries with it the other condition that heat in one way or another must be added to the air before or during expansion, to make up for the work being done and to keep the temperature above the freezing point after exhaust. Heating the air previous to admission to engines which do not use it expansively is also of great benefit, and acts in two ways. In the first place the increased temperature causes an increase in the volume of the pressure air in direct proportion to the absolute temperature before and after heating; and secondly, the heated air warms the cylinders and keeps them at such a temperature that efficient lubrication can be maintained. Without heating, the oil freezes and does not achieve its object, and glycerine, which is mostly used as a substitute, does not appear to be a good lubricant at low temperatures.

With heated air there is, consequently, an increase in the mechanical efficiency of the motor amounting to from 10 to 15 per cent. It is astonishing to witness the effect of heating air ever so little, say from 60° F. to 120° F., corresponding to an increase in volume of from 1 to 1·11, or in the ratio of the absolute temperatures = 520° to 580°. Supposing the motor to be fully loaded and running at the maximum speed it will attain under the load, the revolutions will immediately increase, and the machine will begin to run freely. An increase of 55 per cent. in the volume of air supplied to a non-expansive motor can be made by heating the pressure air to 350° F., at which temperature there is no difficulty of lubrication; this corresponds to a saving of 33½ per cent. in the air used. The exhaust in such a case would be hot.

Unless the heating could be done with a much smaller expenditure of fuel than would be possible with steam machinery, it would be out of the question to propose it. The conditions, however, are so much more favourable to the air plant that the heating becomes a very inexpensive and simple matter.

Air being a permanent gas, the whole of the heat applied to it is available for use again, because there is no change of state to be accomplished; whereas with steam only a small percentage of the heat employed for its production can be drawn upon for work, the remainder being used up in changing the state from water into steam. On account of low temperature of the inlet air, the products of combustion can also be cooled lower than in a boiler, and the stoves can be arranged on the counter-current principle, so that very efficient heating results.

With good arrangements ¼lb. of coke burnt per hour per indicated horse-power is sufficient to heat the air required in a moderate-sized expansive engine, and such a small matter as, say, 5lb. of coke per hour for an engine indicating 20H.P. is not of great consequence when it enables the efficiency of the whole system to reach 80 per cent. Even with an inlet temperature of 350° it is not always possible to work with a four-fold expansion in one cylinder, because of the low temperature of the exhaust; the heating is therefore preferably carried out in two stages by using a compound engine wherein the air can be reheated in the intermediate receiver after passing through the first cylinder and before entering the last. The actual heating can be done in a variety of ways. For small motors small cast-iron stoves are used, the body of which is formed of a double wall, leaving an annular space through which the air can pass in a thin layer, while inside a small coke fire is kept burning. For larger sizes, perhaps the best form is the tubular coil of pipes, protected from the fiercest direct heat of the fire, yet surrounded by the products of combustion on their way to the chimney. A heater 2ft. 6in. diameter by 5ft. high is ample for supplying a pair of cylinders 13in. diameter by 18in. stroke, working with expansion, but not compound. Coke is the most convenient and cleanest fuel to use. Other systems of heating can also be adopted, such as the placing of a lighted lamp in an enlargement of the main and allowing the products of combustion to be carried into the engine. This method is not suitable for any but continuous-running machinery. Heating by passing a current of electricity through a resistance coil placed inside the pipe can also be done.

Finally, we can take advantage of the laws of saturation in order to increase the efficiency of our motor, by supplying steam or aqueous vapour to take the place of that which we condensed out of the air by compression, and which will be required again to resaturate the air when expanded. In this way we are enabled to gain great economy without complication.

Supposing that a small quantity of water is admitted to the air as it enters the heater, it will be turned to steam in the heater, and when expansion takes place in the engine the steam will give up heat to the air as required, until the whole of the steam is condensed into suspended moisture, though a great deal of it will be required to saturate the air when occupying the increased volume due to expansion. Very little water is required, on account of the considerable amount of heat set free when the steam condenses into water, thus giving up its latent heat. A regulated amount of water can be supplied by using a small tank with connections exactly similar to those of an ordinary drop-feed steam lubricator.

The whole of the apparatus connected with the motor is of the simplest kind, requiring little attention, and being easy to replace; the motor itself is as simple as the commonest steam engine, and even more long-suffering; if a joint gives out no one is scalded and no damage is done; the engine can be started at a moment's notice under full load; and the skill required is of such an elementary character that any person who can turn a valve handle in the right direction has sufficient for the purpose.

In conclusion, gentlemen, I would point out the usefulness of this kind of power transmission for use in towns.

With it every house could be supplied with electric light by means of its own dynamo, driven by the air motor, which is always ready to start. All users of power could proceed with their business without causing any smoke nuisance, and the exhaust air would not only assist in ventilating rooms, but could also be used in the summer as a means of cooling them, and in the winter as a means of warming. Meat could be preserved by the cold-air method, while power would be generated for other purposes in other departments. It could be used by the largest as well as by the smallest concerns; for driving the factory or for turning a single sewing machine; for hairdressers' brushes or dental drills; for raising acids and cleaning carpets; for lifting the publican's beer, or blowing organs; for high speeds or low speeds; for pneumatic despatch tubes and safety hoists, and for multitudes of uses which arise in every-day life. And all these diverse deeds would be performed by a safe and cleanly servant without danger to life from its highest tension, with simple machinery of the every-day kind. In places where danger from fire might arise, the air could be used

cold, and all danger would cease. In fact, for its universal adaptability, great simplicity, and high efficiency, it has few, if any, equals.

The times in which we live are daily growing more exacting; wages increase; hours of labour diminish; the sky must not be fouled by smoke, and the safety of the individual is paramount. Yet, if we must prosper in the race of life we must surpass competitors in lands not yet so thickly populated, whose people are content with scant luxuries and little leisure; and without we avail ourselves of every means to facilitate our object we shall fail in the race. The centralisation of the supply of our primary necessities as a manufacturing community seems to be the most urgent step at present, and when we have our water, gas, electricity and power all brought to hand and working together to form a harmonious band of helpers, we shall see the unsightly factory chimney disappear, the domestic chimney will no longer vomit smoke, and the blue heavens will again become visible as they were before the advent of that great personage, the 19th century engineer, who has done miraculous deeds, both in spoiling the face of the country and in improving the lives of the people.

Society of Engineers.

THE next ordinary meeting of this society will be held at the Town Hall, Westminster, on Monday next, March 6, when a paper will be read on "The Leicester Main Drainage, etc., and the Construction and Testing of the Sewage Pumping Engines and Boilers," by Mr. E. G. Mawbey, of which the following is a synopsis:—Statistics of the borough, floods prevention works, storm outfall drainage works; main intercepting sewers, etc., and storm outlets; sewage disposal works, sewage pumping station; construction of the engines, pumps and boilers; the official testing of the engines and boilers, tables and illustrations, cost of the various works.

Shipbuilding Notes.

Several orders have been booked by Messrs. Palmer and Co., of Jarrow, for new vessels, including a large four-masted sailing ship.

On the 20th ult., Messrs. Fleming and Ferguson launched from their yard at Paisley a steel screw yacht for the Foyle and Bann Fishery Board.

Messrs. Simons and Co., Renfrew, and Messrs. Fleming and Ferguson, Paisley, have each booked orders for two 1250-ton hopper barges for the Clyde Trust.

Messrs. Armstrong, Mitchell and Co., have commenced the construction at their Elswick yard of a large cruiser, ordered by the Chilian Government.

The sailing ship "France," the largest sailing ship afloat, has just completed one of the record passages from Shields to Valparaiso, completing the voyage in the short space of 76 days.

Messrs. Bishop, Miles and Co., Bristol, launched, on the 20th ult., a steel screw passenger steamer, built to the order of Messrs. J. R. Brookman and Co., for service on the river Avon.

The largest vessel hitherto built at Irvine was, on the 21st ult., launched from the yard of Mr. Gilmour. Her dimensions are:—Length, 145ft.; breadth, 24ft.; depth, 11ft. The engines are to be supplied by Messrs. Muir and Houston, Glasgow.

On the 21st ult. there was launched from Earl's Engineering and Shipbuilding Yard, Hull, the steamer "Chelmsford," built to the order of the Great Eastern Railway Company. She is of the following dimensions:—Length, 300ft.; breadth, 34·6ft.; and depth, 16ft.

The torpedo boat "Satellite," built by Messrs. Schichau and Co., Elbing, Germany, for the Austrian Navy, was recently taken for her trial trip. The vessel is 220ft. long, 25·9ft. beam, displacement 500 tons, and is fitted with engines of 4600H.P. A speed of 21·86 knots was attained.

On the 18th ult., Messrs. Ropner and Son launched a steel screw steamer of the following dimensions, viz.:—Length over all, 335ft. 6in.; breadth, 41ft. 6in.; depth, moulded, 23ft. 8in. Her triple-expansion engines are by Messrs. Blair and Co. Limited, of 1100I H.P., with two large steel boilers working at 160lb.

On the 20th ult., the large new screw steamer "Sultan," which has been built by Messrs. Wood, Skinner and Co., Bill Quay, to the order of Mr. Otto Thorlsen, of Tonsberg, left the Tyne for her trial trip. The dimensions are 275ft. long by 37ft. 6in. beam by 19ft. 6in. draught, and carries a deadweight cargo of about 3200 tons. The engines, which have been supplied by the North-Eastern Marine Engineering Company Limited, Wallsend, are of about 1000I.H.P., and are capable of driving the vessel 10 knots fully laden. The mean speed attained on the measured mile was 11½ knots, which was considered highly satisfactory.

Winding Engines.

ENGLISH engineers' training is reproached with being deficient in theoretical instruction, while young German and French engineers, on leaving their several professional schools, lie under the imputation of being found wanting in practical experience. Indeed, it has even been irreverently observed that they know everything, but can do nothing. This, of course, is an exaggeration in the great majority of cases, as is shown by the many excellent works subsequently turned out by Continental engineers, especially the mining work in the Ruhr, the North of France, and the Saint Etienne districts. The training of engineers in the two latter localities must certainly partake of the nature of that at the Liège University and School of Mines, Belgium, which has been referred to as hitting the happy mean between a purely theoretical and a purely practical education. "Sweet are the uses of adversity"; and the dangerous character of mines round Saint Etienne has no doubt been the primary cause of the great attention paid to ventilation and underground lighting which has given to the world such appliances as the Fumat safety lamp and the Rateau ventilator. As to this subject, a well-known English author of authority observes that "in matters appertaining to mechanical ventilation, as also in the safe lighting of mines, foreigners do more than command respect—they deserve it."

The subject of this article is also one in which many a lesson may be learnt by English engineers from their Continental brethren. The usually greater depths from which coal is raised, and the generally higher cost of working, due to thin seams and an inferior product, necessitate stricter attention to economy than in our own favoured isle; and among the points specially attended to may be mentioned refinements in a balanced rope and the judicious, but only judicious, expansion of steam in the cylinder of the winding engine. These considerations were suggested by a communication to the Société de l'Industrie Minérale, Saint Etienne, as to a new winding engine put down at the No. 1 Montmartre shaft of the Beaubrun Colliery, in France, by MM. H. Schneider et Cie., of the celebrated works at Le Creusot, a visit to which, on the occasion of the first Paris meeting of the Iron and Steel Institute, has left an indelible reminiscence in the mind of the present writer.

Though the engine has two cylinders it is not compound, many engineers being of opinion that not only the usual advantages of compounding are not realised in winding engines, but also that admission of steam for nearly the whole length of the stroke is absolutely necessary to ensure safety. Great care was, however, bestowed on economical working, as regards low consumption of steam, without losing sight of the simplicity of design and security which should be the first point to be considered in such engines. The communication in question, by M. Faivelay, contains, in addition to the description of the engine—which possesses some special features,—so many practical observations as to the convenient arrangement of such plant, that no apology is made for laying it freely under contribution in the following particulars:—

The engine, with 80cm. (31in.) diameter of cylinders, and a stroke of 1·6 metre (5ft. 3in.), was designed for raising 1000 metric tons of coal from a depth of 500 metres (270 fathoms) in a day of eight hours, at a speed of 65 revolutions per minute. To secure economy of steam, and consequently low fuel consumption, the admission and exhaust ports were designed of large sectional area, and the dead spaces were reduced as far as possible; while to secure simplicity of working, all new and complicated methods of steam distribution, with springs and detents, have been left severely alone, it having been considered by the engineers that they are not necessary to secure the slight degree of expansion admissible in winding engines. Such engines, observes M. Faivelay, who is an engineer at the Creusot Works (where Corliss engines constitute a specialty), should be of such capacity as will enable them, if required, to raise a loaded cage with a single rope. They are, moreover, generally designed with a view to the eventual deepening of the shaft, so that the dimensions of their cylinders are larger than necessary for their actual work. This unfavourable condition, he continues, added to the absence of condensation and the necessity of avoiding the loss of power which must be experienced if the pressure at the end of the piston stroke fall below the back pressure of the exhaust, necessitates the absence of high expansion and high initial pressure of steam, there being few winding engines in which the steam may be cut off earlier than two-fifths of the stroke.

In the engine under notice the steam is distributed by simple flat slide valves of D section. The reversing and expansion, effected by means of two eccentrics and a Gooch slot link, are controlled by a single lever, which is an essential condition; and the reduction of dead space is effected by dividing the slide valves into two parts, one at either end of the cylinder. All throttling of the steam, even when working expansively, is avoided, owing to the large sectional areas of the ports. And then the large slide valves, necessitated by these large ports, are worked by means of a starting engine (*servo-moteur*). The maximum admission, corresponding with the ends of the slot links, does not exceed 78 per cent., this extent of admission being sufficient to ensure starting at any position of the cranks, and to perform all the operations required during the lift. The expansion increases as soon as the starting is effected, and with this object the engine itself brings the reversing lever into an intermediate position, while lessening by an equivalent amount the path which it will have to cause the lever to pass through at the end of the lift. With this arrangement the engineman, whose attention is sufficiently occupied, has no supplementary manœuvre to execute for regulating the expansion, having only to divide into two periods the total travel of the reversing lever. The training of the enginemen is very easy, and with a little supervision the most satisfactory results are obtained with this simple arrangement, results which could only be improved, as regards consumption of steam, by the addition of condensation, and not by the adoption of any of the other complicated arrangements referred to above.

The starting engine is fitted with an oil brake, communication between the two ends of which is regulated by a small special slide valve, actuated by the helping mechanism of the servo-motor. The addition of this small slide valve has the effect of preventing the ends of the brake from coming into contact, and consequently the piston of the starting engine and the blocks of the slot links may, while working, be stopped and kept in any intermediate position. This arrangement prevents any shocks and recoil which would otherwise be felt by the engineman's hand, and also permits the expansion arrangements mentioned above to come into play. The starting engine is arranged vertically, below the engine-house floor, being supported by two cast-iron columns, which carry the plummer blocks of the weigh shaft. The main shaft has keyed upon it the brake pulley and one of the two winding drums, the other running loose upon it. The drum frames are entirely of cast iron, and carry on their rims the counterweights for balancing the cranks. The insides of the drum arms are also packed with wood, for preventing the edges of the [flat] ropes from becoming worn. The grip brake is so arranged as to tighten under the action of a heavy counterweight, and during the lift the brake is taken off by the steam acting on the under side of a piston and keeping the counterweight raised, the piston and counterweight on the same rod acting directly upon the brake beam. This arrangement is far preferable to that of brakes put on by the steam, as it increases the measure of security, and accidents which may result from the accidental giving out of a steam pipe, or the inopportune closing of the automatic valves of boilers, are suppressed. A too sudden action of this brake would cause shocks that might occasion the breakage of various parts. With a view to avoid these shocks, arrangements are made to delay the exhaust of the steam acting on the underside of the piston for raising the counterweight, and for compensating the wear of the brake blocks and reducing the travel of the counterweight. Moreover, all the parts except the pulley are forged out of the best quality steel, of dimensions calculated far in excess of the strains which they have to withstand.

The automatic tightening of the brake and stoppage of the engine, if the cage should be overwound in the pit head, are effected by means of arrangements invented by M. Reumaux, manager of the Lens Colliery, at once simple, practical, and efficacious, and thanks to which the engine may be driven at a high speed without any fear of danger. Strong frames, cast hollow, bolted down to the bed, carry the main plummer blocks, the slide bars, and the steam cylinders. This arrangement of frame, adopted in all old winding machines, appears to M. Faivelay preferable, for this special case, to closed frames, because the setting up of the slide bars and the piston crossheads after wear is more easily effected; the levelling and lining of the engine, after any settling of the masonry—as too often occurs in mines—are easily accomplished; the connecting rods are more in sight of the enginemen; and lastly, this form of frame lends itself readily to a strong bracing of the two engines by cross-stays, which, maintaining the distance apart and the alignment of the main bearings, prevents all abnormal strain of the shafts and heating of the bearings. There are three of these cross-stays in the Beaubrun engine, which worked well from the first day it was started, since which time no modification has been found necessary in any one of the parts. It may indeed be said, in conclusion, that this strong and simple engine, which works well and economically, is a first-rate specimen of a winding engine—that is to say, of an engine in which the requirements of its work and ease of maintenance are ensured before everything, instead of being sacrificed to problematical advantages.—"Colliery Guardian."

Trade Notes.

The directors of Messrs. Bolckow Vaughan and Co. announce a dividend of 2½ per cent. per annum.

Messrs. W. Lewis and Son, air-pipe manufacturers, Bilston, are carrying out important extensions at their works.

Messrs. Heathfield and Cardowan, Glasgow, have secured the contract for the new retorts for the Rothesay gasworks.

Messrs. Cochrane, pipe founders, Dudley, have obtained an order for heavy pipe castings for the extension of the Birmingham gasworks.

Messrs. Robert Stephenson and Sons Limited, Newcastle-on-Tyne, have received an order for a number of locomotives for South America.

Messrs. C. Lathe and Co., Summerhill, have received an order for the supply of cast-iron mile-posts for the Staffordshire County Council.

The Glenfield Company, Kilmarnock, are making a testing machine for testing the iron of all cast-iron piping supplied to the Glasgow Water Commissioners.

Messrs. Ernest Scott and Mountain Limited, of Newcastle-on-Tyne, have just completed an electric-light installation at the Springfield Paper Works, Bolton.

The Horseley Engineering Company, Tipton, have booked a valuable contract for gasworks machinery for the Gaslight and Coke Company, Beckton, London.

Messrs. Braithwaite and Kirk, West Bromwich, are supplying their patent trough flooring for several important bridges, including some on the North-Eastern Railway.

The contract for the new 20-ton weigh-bridges required for the extensions at the Dawsholm Gasworks has been placed with Messrs. Henry Pooley and Son, Albion Works, Glasgow.

Messrs. John Brotherton, Imperial Tube Works, Wolverhampton, have added to their manufactures the production of iron and steel bottles of all sizes for the conveyance of compressed gas.

The Consett Iron Company has entered upon the manufacture of Siemens-Martin steel ship angles, bulbs, bulb angles, bulb tees, and other sectional steel for shipbuilding and engineering purposes.

The directors of the Gloucester Railway Carriage and Wagon Company Limited have declared an interim dividend of 3s. 6d. on the class A shares, and 1s. 9d. on class B, being at the rate of 5 per cent. per annum.

Messrs. J. Oakes and Co., of Wharf-road, City-road, London, have secured the contract for the supply and delivery of about 2200 lineal yards of 36in. diameter and about 700 lineal yards of 33in. diameter turned and bored cast-iron pipes, for the Blackburn Corporation.

The directors of Bell's Asbestos Company Limited have resolved to recommend the payment of a balance-dividend of 5s. per share, free of income tax, which, with the interim dividend paid in July last, makes a total distribution of 7½ per cent. for the year 1892, as against 10 per cent. in 1891.

The "Waterspout" Pulsating Steam Pump.

In the engineering, mining, and manufacturing industries it has long been recognised that for certain purposes pulsating steam pumps possess marked advantages over any other variety. In cases of emergency they often prove of the greatest possible service, as they are competent to raise large quantities of water, and can be readily and quickly placed in position and set to work.

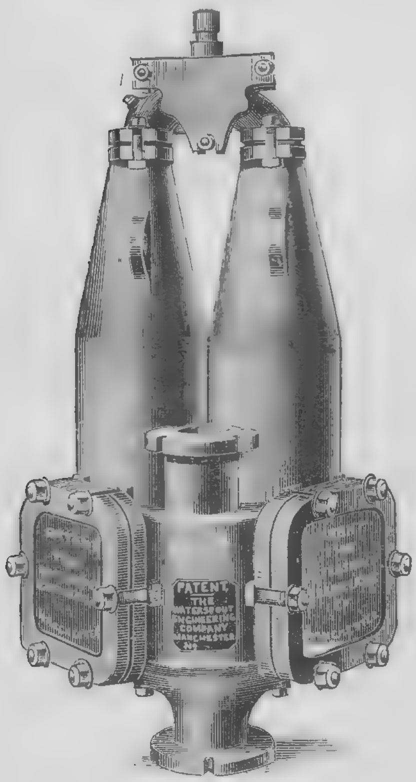


Fig. 1.

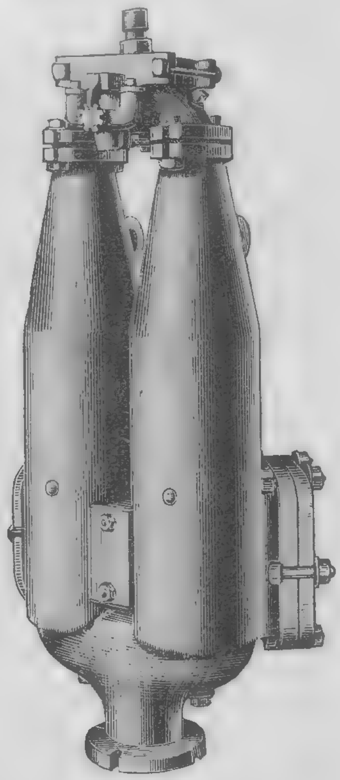


Fig. 2.

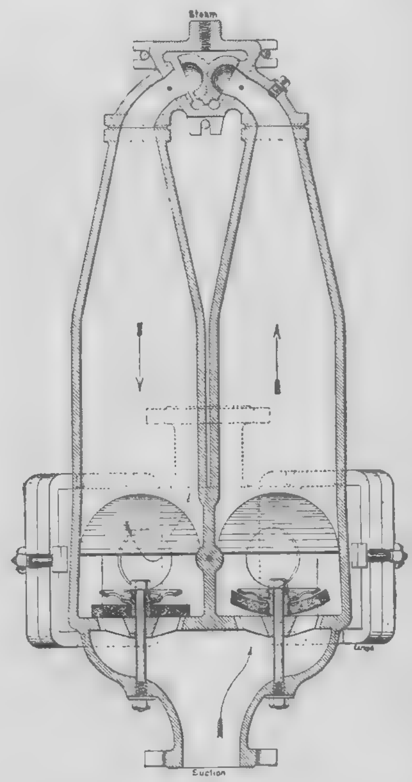


Fig. 3.

We have recently had brought under our notice an improved form of pulsating steam pump which is being introduced by the Waterspout Engineering Co., Sidney-street, Salford, Manchester. Of the accompanying illustrations, Fig. 1 gives a front view, Fig. 2 a back view, and Fig. 3 a sectional elevation of the apparatus. From these views it will be gathered that the Waterspout pump consists of two working chambers formed in one casting, below which is the suction chamber, while in front (Fig. 1) is the delivery chamber. From Fig. 3 it will be seen that openings are provided between the suction chamber and the two working chambers, in which are placed the suction valves. It will also be understood that similar openings, provided with delivery valves, are formed in the walls separating the delivery chamber from each working chamber. Openings furnished with planed covers are provided on each side of the main casting, for the purpose of rendering these valves easily accessible, either for examination or repair. In the head casting, which is bolted to the tops of the working chambers, a triangular steam chest is formed, as shown in Fig. 3. This, as will be seen, contains a wedge-shaped valve, consisting of two hollow semi-spheres joined together at their convex surfaces, and furnished at the lower part with a bearing bar or rocking strip. Suitable faced seatings are provided in the steam chest, and the angle formed by the two flat faces of the valve is such that it allows the requisite amount of "play" between the valve face and seating on either side of the steam chest, so that as it oscillates from side to side steam will be admitted alternately to each of the chambers. The makers claim that as the bearing strip of the valve has a long bearing surface, its durability is much greater than that of any other type of valve, while it can be readily taken out and refaced when desired.

Steam is admitted by means of a pipe communicating with the top of the head casting, and entering one of the working chambers, forces the water out through the delivery valve under the inclined partition, as shown by the arrow in Fig. 3, and into the discharge pipe. As soon as the water level falls below the bottom of this partition, the steam rushes through, producing a considerable amount of agitation, and causing condensation to occur. The vacuum thus formed causes the steam valve to close, and as the further admission of steam is thereby prevented, the creation of the vacuum is completed, and a fresh supply of water immediately enters the just-emptied chamber. As one chamber is filling while the other is emptying, a practically continuous discharge is obtained.

The makers claim that the special form of steam valve used may be readily refaced without disconnecting any pipes or disturbing the pump connections in any way; also that its construction ensures great durability, while at the same time it allows the steam-valve opening to be adjusted as desired by filing away a portion of the underside of the bearing bar. The air valves are cast in one piece, and form part of one of the corners of the steam chest. They are simple in construction, and have only one screw, which regulates the air admission to both chambers. In this way both receive an equally small amount of air, thus ensuring regular and steady working. It is claimed that it will work suspended by a chain and with almost any steam pressure. It requires no skilled attention, and is capable of dealing with any kind of liquid or semi-liquid containing from 30 to 50 per cent. of solid matter. It may also be used for a ship's pump and for wreckage purposes.

We may add that we have had an opportunity of seeing one of these pumps at work, raising about 20,000 gallons per hour and working under a head of 50ft. The apparatus worked well, uniformly and quietly, and appeared to be giving very satisfactory results. Further particulars may be had from the makers at the address given above.

Sugar-making Machinery.

XXVIII.

Fig. 67 shows the improved De Morney mill, manufactured by Messrs. Fawcett, Preston and Co., of Liverpool. The canes in this mill enter between the larger roller A on the left and the smaller roller B beneath, and are carried onwards by the larger of the smaller rollers C underneath, and placed behind roller B, from which the canes emerge to be taken between the two larger rollers above.

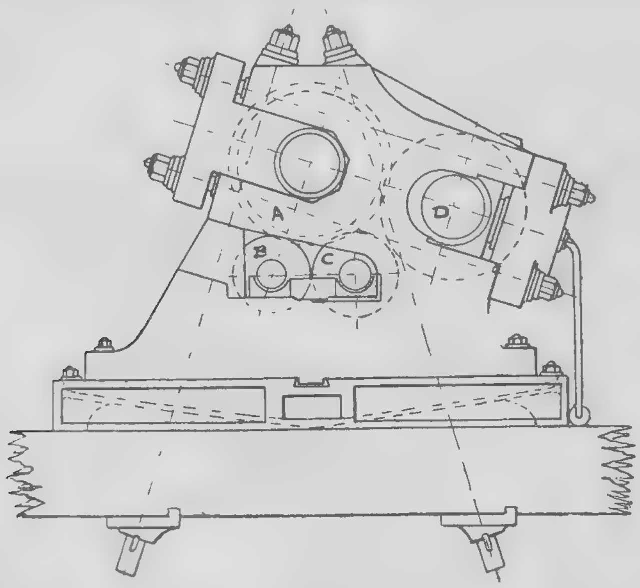


Fig. 67

Sugar-making Machinery.

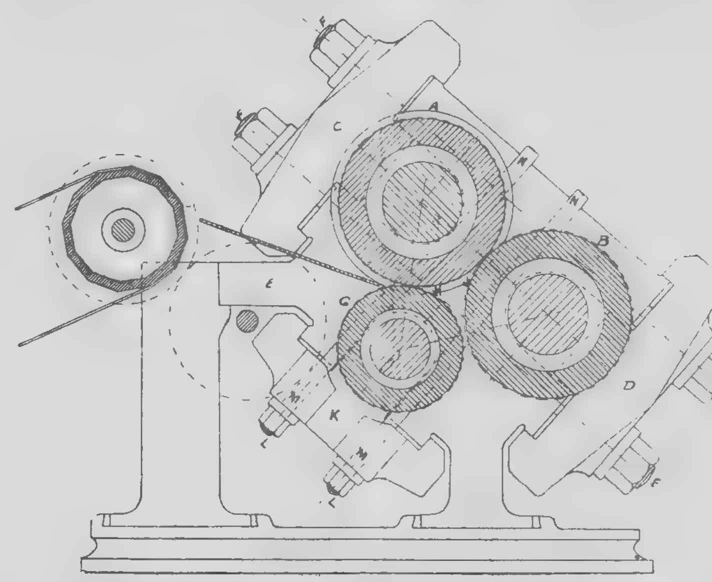


Fig. 68.

The advantages claimed for this mill are that there are no "dumb-returner" bars to cause excessive friction, and no sliding or rubbing of the top rolls on a mass of crushed canes, which act as a powerful brake to absorb much useful power. The lower of the larger rolls D, it will be seen, is adjusted by means of a hydraulic cylinder formed in the cap, by means of which a more constant pressure is obtained. The pressure in the cylinder is derived from a hydraulic accumulator, charged by a hand pump. The main bolts pass right through, taking up all stresses, and to a great extent relieving the headstocks. An improved scraper is provided for removing the megass from the main roll. It is brought up over the top roll, but without touching it, and is then bent downwards till it touches the roll, thereby removing the megass from contact with the roll as soon as possible after crushing. It is claimed for this arrangement that it effectually prevents the reabsorption of the juice by the megass.

Fig. 68 illustrates a mill recently introduced, and intended to combine all the advantages of double crushing in one apparatus. It is the invention of Mr. Robert Allen, of the Demerara Foundry Company, Demerara. It is so constructed as to dispense with what is known as the dumb returner or guide for leading the canes round from the first to the second gripping and crushing positions. It will be seen by a reference to the figure that the top roller A and the second lower roller B, which are made as usual of about the same size, are placed with their axes in a plane which is rather more inclined than in ordinary mills. The caps C and D are connected and held by two long bolts F parallel to the plane of the axes. The other lower roller G is made smaller than the rollers A and B, and is placed almost directly below the top roller A, and as closely as can be conveniently arranged into the bight or curvilinear angle between the rollers A, B; and in consequence of the comparative smallness of this roller G and its position the ordinary dumb returner is rendered, it is said, quite unnecessary, as the canes pass without difficulty from the part H, where they are first partly crushed between the top roller A and the small lower roller G, to the part J, where they receive the final crushing between the top roller A and the large lower roller B. Each cap K of the bearings of the small lower roller G is secured by four nuts L screwed upon the ends of bars M, which are in the form of long staples passing along the sides of the housings on frame E, and with their cross ends N engaging therewith. The driving, gearing, and other accessories are as in the ordinary mill. It is of the utmost importance, in order to obtain good results in cane-crushing, to have a regular feed of canes, evenly spread over the carrier, so that a uniform pressure may always be exerted on the canes throughout the day's working. This ideal is not easily reached, as it is almost impossible to keep an even layer of canes on the carrier, with the result that thick bundles of canes on passing through receive excessive crushings, whilst, on the other hand, the thin layers pass through imperfectly crushed. If the front rollers are set, say, 1in. apart, and the back roll ¼in. from the top roll, and the layer of canes on the carriers averages 12in. deep, the layer of canes in passing through between the first two rolls is compressed to $\frac{1}{12}$th of its original depth, and in passing between the back rolls is compressed another ¼th, or in all receives a compression of $\frac{1}{48}$th of its original thickness. Suppose, however, that parts of the carrier have a depth of cane of only 6in. (the rollers being set with a constant opening for a 12in. feed), it is plain that the canes are crushed to only $\frac{1}{24}$th of their original thickness, or practically they receive only half the crushing of the deeper layer. This fault causes great loss of valuable juice, and many devices have been devised to remedy this by providing some automatic attachment which will keep the pressure on the canes constant whatever the thickness of the feed.

This has been effected in various ways, such as by using compound levers and weights acting on the top roll; toggle joint arrangements; steam pressure acting through cylinders and lever combinations, and by means of hydraulic cylinders. This latter method has been adopted with very good results, the main objection being the increased first cost for the mill and hydraulic attachment, requiring, as it does, an accumulator and hand pump for its equipment, occupying extra space, while the hydraulic leathers and joints require skilled attention.

(*To be continued.*)

Marine Boiler Furnaces.

(*Continued from page 74.*)

MESSRS. JOHN BROWN AND CO., of Sheffield, made the first test with the Purves flue in March, 1887. Two flues were tested, each nominally 9/16in. thick and 6ft. 6⅜in. long between the centres of the inner row of rivets by which it was secured to the angle-iron bars. There were seven ribs with a pitch of 9in., and the two end ribs were 8 11/16in. and 15 11/16in. respectively from the centres of the inner row of rivets. The end flats were unusually long, and were in fact the weakest part of the flue. Each rib projected 1in. above the level of the plate on the outside; the plate was grooved on the inside to a depth nearly equal to the thickness of the plate. The greatest deviation of the first tube from the circular form was 7/32in., and of the second tube 11/32in. Collapse took place with the first tube at 740lb. on the 15 11/16in. plain part about 18in. from the weld, the second tube collapsing at 760lb., also at the long flat in the front end, and about 24in. from the weld. Measurements were taken at 12 test holes in each case, and the thickness was found to be 0·568 in the first, and 0·546 in the second.

Taking the external diameter of the flats as being the diameter acted upon by the water, the collapsing coefficients are:—

$$\frac{740 \times 38{\cdot}61}{0{\cdot}568} = 50{,}302;$$

$$\frac{760 \times 38{\cdot}685}{0{\cdot}546} = 53{,}847;$$

or a mean of 52,074. The mean tensile strength of the material unannealed was 26·9 tons, and as this result was much inferior to that obtained by Messrs. Hall, Russell and Co., and James Howden and Co. with Adamson rings, and as these flues were somewhat roughly made, Messrs. John Brown and Co. arranged another series of tests.

Of this second series two furnaces were nominally 5/16ths, two 7/16ths, and two 9/16ths thick. Each of the 7/16ths and 9/16ths flues were made from a plate which had been rolled to the form and thickness required, but the 5/16th tubes were made from plates rolled similar to the 9/16th and afterwards planed on the ribbed side to the required thickness. Each tube was 6ft. 7½in. in length between the centres of the inner rows of rivets, and there were eight stiffening ribs pitched 9in. apart. The centres of the two outer ribs were 6¾in. and 9¾in. respectively from the centres of the inner rows of rivets in the end rings; the ribs projected about 1 5/16in. above the outer surface of the tubes, and were grooved to a depth of about ¾in., as shown in Figs. 10, 11, 12, 13. A section of the furnace in position in the test tube is also given in Fig. 9.

A point to be noted in this second series of tests of the Purves flue is the rapid reduction of the collapsing coefficients as the thickness of the flue increases; thus, the mean collapsing coefficients for 5/16in., 7/16in., and 9/16in., were respectively 81,980, 58,327, and 55,435. The chief cause of this reduction in strength is that the amount of metal in the strengthening ribs is practically a constant quantity, and therefore bears a less proportion to the total in thick flues than in thin.

Comparing the results obtained from the 9/16th furnace in the second series of tests with the results obtained from the same thickness in the first set, the collapsing coefficients are respectively 55,435 and 52,074. The slight gain, amounting to about 6½ per cent., may be due to the increased tensile strength of the steel (27·9 against 26·9), to the shorter flats at the ends, or to the increased depth of the strengthening ribs. These causes are sufficient to account for a greater increase of strength than was actually obtained, and it is probable that had the 7/16th and 9/16th furnaces been more satisfactory in form, a higher collapsing coefficient would have been obtained.

As it is very seldom that 5/16th furnace flues are used in practice, the results of this thickness being so much in excess of the others should be neglected, and the mean of the 7/16th and 9/16th taken as representing the strength of the flues in actual use for marine boilers. The mean of these four tests is 56,881, which is still considerably under the coefficient obtained with Adamson's rings.

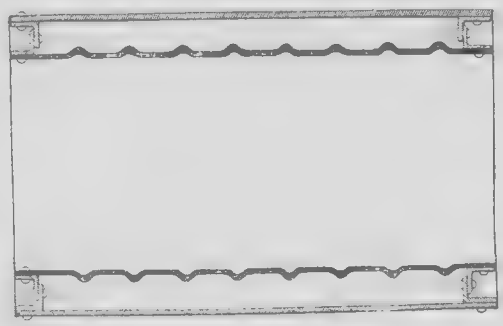
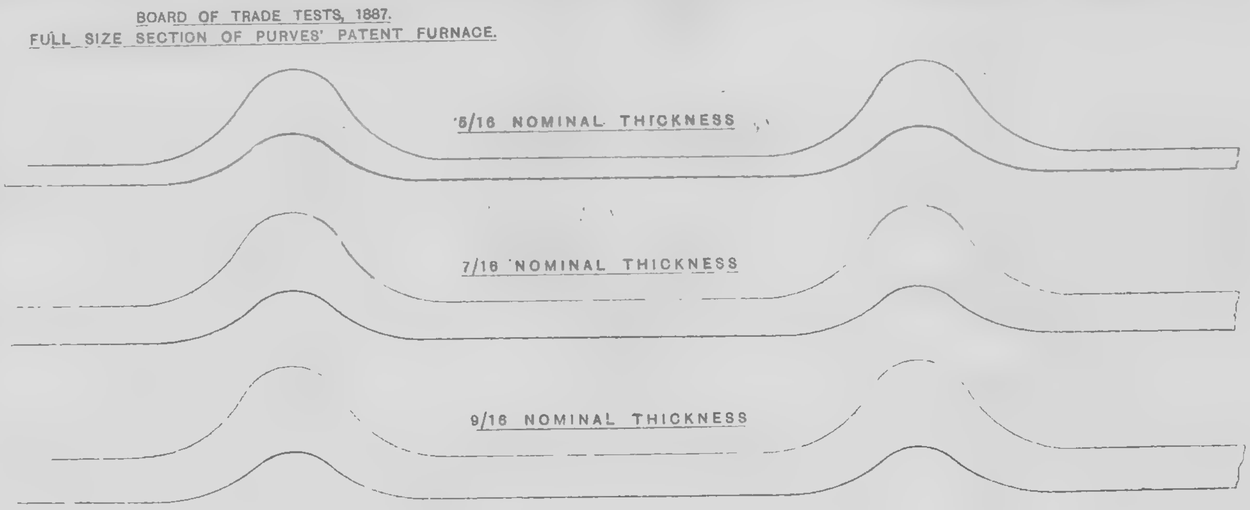


FIG. 9.

Messrs. John Brown and Co. being still dissatisfied, prepared another set of furnaces, which were tested in the same manner in 1889 by the Board of Trade only, and one furnace which was tested by Lloyd's in December, 1890.



FIGS. 10, 11 AND 12.

In September and November, 1891, experiments were made by the Leeds Forge Company upon six of Morison's suspension furnaces. These furnaces were made of steel having a mean tensile strength of 27·17 tons per square inch, and the results obtained were remarkably uniform, and may be considered absolutely reliable, as the severity of the Board of Trade requirements, the strict supervision of the entire process of manufacture, including the annealing of the furnaces prior to being riveted in the test tubes, were all carried out with a degree of exactness never exceeded. Of the six furnaces tested two collapsed on the end flats, and the remaining four on the corrugations; the mean length of flat was 4¾in., and as it is not necessary that the corrugations should be alternated in a boiler, no longer flat than this need ever be used in practice. The average collapsing coefficient given by the six furnaces is 82,185, which is slightly higher than that given by the Fox flues, which were made of 29·07-ton steel. Reducing both to a basis of 27 tons, we have:—

Morison's collapsing coefficient	..	81,641
Fox's " "	..	75,153

showing Morison's tests to have given a result of 8½ per cent. better than Fox's. The depth of the corrugations for these test furnaces was 2in., but as it was considered necessary that the body of a furnace should be the strongest part, the rolls were cut ⅛th deeper, so the furnaces as since made are stronger than those tested.

FIG. 13 AND 14.

Fig. 15 shows Morison's furnace and test tube in section, and Fig. 14 gives a full-size section of the corrugations.

The diagram Fig. 16 shows the collapsing coefficients of the furnaces mentioned in this paper, the coefficients being calculated by the formula:—

$$\frac{P \times D}{T} = \text{collapsing coefficient.}$$

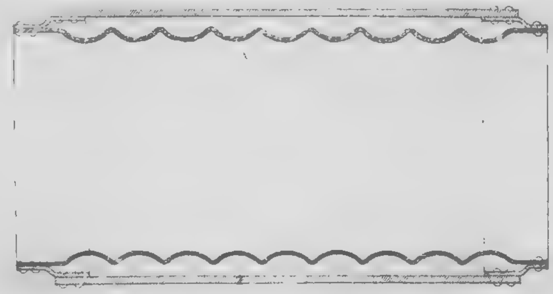


FIG. 15.

The diameter D being the mean diameter in the cases of the Fox, Farnley, and Morison furnaces, and the least external diameter for the Purves, Holmes, and Adamson. The coefficients so found have been brought to the common basis of steel of 27 tons tensile strength, so that they may be directly compared. As two furnaces of each thickness were tested in most cases, the mean has been taken, and the points in the diagram show the position of these means. The abscissæ show the thickness of the test furnaces and the normals represent the collapsing coefficients. The furnaces in practical use being generally of greater thickness than 7/16ths,

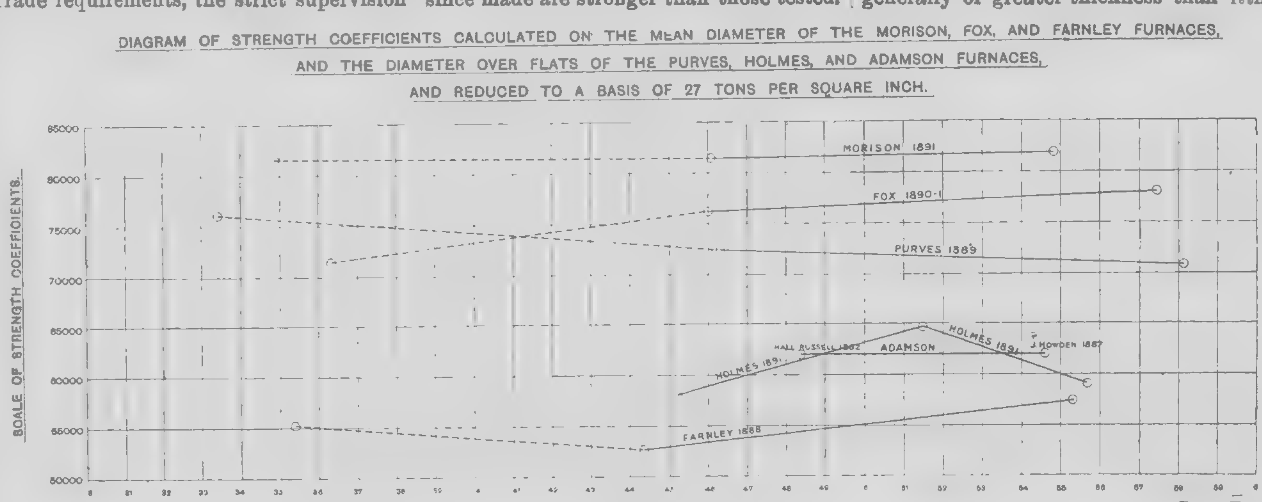


FIG. 16.

the furnaces under this thickness are shown in the diagram by a dotted line.

The tests of the suspension furnaces are remarkably uniform, being represented by

an almost horizontal line, thus indicating that the strength of each thickness of furnace is exactly proportional to the thickness of the plate. The low position of the 6th Fox furnace may be ascribed to the fact that it was thin at one end, while the drooping line of the Purves tests shows the influence of the strengthening rib, which is greater in thin furnaces than in thicker ones.

It would seem that the Farnley and Holmes tests had not been so accurately carried out as the others, both as regards the manufacture of the furnaces or the method of testing, or the tests would probably have been more uniform.

FLATS ON FURNACE ENDS.

The test value of modern marine furnaces depends to an extent on the length of the flat parts of the ends. Fig. 23 gives the results of those test furnaces which collapsed at the end flats, the collapsing coefficients having been calculated by taking the external diameter.

Where $\frac{P \times D}{T}$ = collapsing coefficient.

P = pressure per square inch at which collapse took place.
D = external diameter of the flat.
T = thickness of flat in inches.

In each case the collapsing coefficient has been reduced to a basis of steel having a tensile strength per square inch of 27 tons. The diagram includes all the Fox, Purves, and Morison test furnaces which collapsed on the flat, the diagonal line representing the mean result.

In the Morison furnace no flat need exceed 4¾in., and the Board of Trade have fixed the limit at 5in., or 1in. less than in the Fox, the explanation of this difference being that the design of the former is more suitable for short flats than the latter. By the aid of the diagram the collapsing coefficient of any length of flat can be found with any furnace of the modern types. Neglecting the irregularities of the tests, which may be due to one furnace being more nearly circular than another, it is seen that the strength of an end flat bears an inverse ratio to its length. The weakest flat is at the top back end over the bridge, but this in practice can be reduced to a minimum. Flats at the front end and the bottom back end are not exposed to such a high temperature, consequently the end plates in a furnace when in use are probably stronger than that part of the body of a furnace exposed to the greatest heat.

It has lately been the custom, when the flat at the back bottom end exceeds the regulation limits, to roll in a corrugation half-way round in a Fox furnace, and hammer out a rib half-way round in a Purves design; but unless the flat is very long this appears unnecessary, as deformation or collapse does not generally take place in the ashpit, except when the furnace is too rigidly stayed.

(To be continued.)

Manchester Association of Engineers.

On Saturday, Feb. 25, a meeting of the members of the Manchester Association of Engineers was held at the Grand Hotel, Aytoun-street, Manchester. Mr. T. Daniels, president of the association, occupied the chair, and there was a good attendance. A paper on "Felt Hat Manufacture and Machinery" was read by Mr. J. Marshall, Hyde. He said the subject was one which had not received much attention from mechanical engineers, with the inevitable result that, in a general sense, it was but little understood. Still the trade in felt hats, whether considered as a question of home consumption or one of export, was by no means inconsiderable, and its progress and present magnitude showed an advance in quantity, coupled with a singularly corresponding decrease in the price per dozen, which he ventured to think would be both striking and agreeable to those who recognised the inevitable cheapening of production which invariably followed mechanical invention. He then went on to call attention to the satisfactory fact that, while we practically imported no hats, we did export them in large and ever-increasing quantities. The trade had been left to the enterprise of employers and the industry of the workmen, with the result that England had far away the largest export trade in hats in the world; and that whereas in 1855 our exports of hats were so small in quantity and value as not to be thought worth classifying, except under the miscellaneous head of haberdashery, in 1891 those exports had risen to the satisfactory quantity of 1,142,869 dozens for the eleven months ending November, to the value of £1,098,022 sterling. This state of things he regarded as very satisfactory.

Hints to Intending Seagoing Engineers.

[CONTRIBUTED.]

The following information concerning the qualifications and duties of an engineer on board a steamer may be useful to many intending seagoing engineers.

An engineer presenting himself for examination for a Board of Trade certificate of competency as a second-class engineer in the merchant service requires to have had 12 months' sea experience (this time being reckoned from the discharges or the actual time on the ship's articles). The regulations are:—

1. A candidate for second-class engineer's certificate of competency must be over 21 years of age.

2. He must have served an apprenticeship to an engineer for not less than three years, and prove that during the period of his apprenticeship he has been engaged on the making and repairing of steam engines; or if he has not served an apprenticeship, he must prove that for not less than three years he has been engaged as journeyman mechanic in some factory or workshop on the making and repairing of engines. These may be either land or marine engines. In either case he must have served one year at sea in the engine room—as engineer on watch—in the foreign trade, or one year six months in the coasting trade.

3. He must be able to give a description of boilers and the methods of staying them, together with the use and management of the different valves, cocks, pipes, and connections.

4. He must understand how to correct defects from accident, decay, etc., and the means of making good such defects.

5. He must understand the use of the barometer, thermometer, and salinometer, and the principles on which they are constructed.

6. He must state the causes, effects, and usual remedies for incrustation and corrosion.

7. He must be able to state how a temporary or permanent repair could be effected in case of derangement of a part of the machinery or total breakdown.

8. He must write a legible hand and understand the first five rules of arithmetic and decimals, with their application to questions as to consumption of stores, the full capacities of tanks, bunkers, the duties of pumps, and the direct strains of engines, boilers, etc.

9. He must be able to pass a creditable examination as to the various constructions of paddle and screw engines in general use, as to the details of the different working parts, external and internal, and the use of each separate part.

Such are the conditions, which at first sight may appear of a very stringent character. A careful, industrious, and energetic young engineer will, however, soon find himself at home on the subject, for the only safe guide for passing in future examinations is to become thoroughly conversant with the principles of the steam engine. He ought therefore to be able to explain the why and wherefore of everything concerning the action of the steam engine, the combustion of fuel, and the strength of materials used in the construction of engines and boilers. The possession of such knowledge will be to the engineer a source both of profit and pleasure. Every feature of the engine becomes a study to him, and he delights in attending to his duties. He has confidence in himself that what any man can do with machinery he ought to be able to do, and in these days of competition this is a very important factor towards success. His care and watchfulness will be exerted to discover the first sign of any defect, and he will be able to take the best means to guard against an accident or to effect repairs should one take place.

A few hints will not be out of place here to give the young engineer some idea of what he will be expected to do, together with a few remarks about obtaining a start in the seagoing line, as it is sometimes very difficult to get away to sea for the first time. According to Board of Trade regulation No. 2, the applicant must have served an apprenticeship to the making or repairing of engines. It is not necessary that these should be of the marine type, although there is no doubt that the apprentice in a marine shop would have a better chance of understanding the internal parts, and would have a better grasp of his work with these particular engines when overhauling, than one who has not had anything to do with such work; therefore we would strongly advise all to whom our remarks are addressed to supplement their knowledge with at least 12 months' service in a marine shop.

There are certainly a large number of men who have gone direct from inland shops to sea and been very successful, and in this matter self-confidence and energy have a great deal to do with their success. But as the duties of the marine engineer are so very different at sea to what they are in the works, the intending engineer will find it to his advantage—even if he cannot conveniently obtain employment in a marine works—to work for a few months in the shore gang (this is the name given to the batch of men engaged in overhauling the machinery whilst the boat is in port) of the company he wishes to join. During this time he will see—if he keeps his eyes open—and learn many things that will be of great service to him when once he obtains his long-desired appointment as third, or in a larger steamer as fourth engineer. We really could not advise young engineers to go in for passenger or mail boats in the first instance, although no doubt they have great attractions for the uninitiated. It is the duty, and certainly the best policy, of every young seagoing engineer to get the Board of Trade certificates as early as possible. Being fourth engineer in a boat where more than three engineers are carried, or third where only three are carried, or second where only two are carried, will qualify for the examination for second-class certificate of competency. Now in the mail or passenger service, where eight or twelve engineers are carried, a young fellow may be many years before being able to get in the required qualifying time to enable him to sit for examination. As to obtaining a start in the business, this is a great difficulty in some cases, especially if the candidate does not happen to have any interested friends to give him assistance. Now if the intending engineer has had a good shop training, he should make application to the superintendent engineer of some steamship company for a start, intimating his willingness to serve in the shore gang, with the idea of eventually going out to sea in their boats. The candidate must not be discouraged if he is not engaged at once, for sometimes hands are not required for a short time. Eventually something may turn up and they will require a few at short notice. When thus engaged, it will be to the young engineer's advantage to be civil and attentive to all around him, never allowing himself to assume the air of knowing too much. He should get to know all he can, and watch how the different work is carried on; he should, of course, be attentive to his own work, and he may take it that he will be closely watched to a large extent, if not by the superintendent himself, by some of the permanent staff. Of course the candidate must not be afraid of dirt, of which there is plenty after a boat has been away about three months on a voyage. Whatever he does, quality must be the first consideration. There is nothing will cause more trouble than when steam is being got up to find that some of the joints of the valves or pipes are leaking, causing trouble and annoyance, and possibly delaying the ship from sailing at the properly-appointed time.

(To be continued.)

Peat as Fuel.

(Continued from page 65.)

The felt rollers expel about 60 per cent. of the water contained in the peat as it comes from the bog. Of the remaining 40 per cent. 30 is driven off by the heated cylinders, and 10 per cent. is retained in the finished article, Mr. Dickson stating that he finds it preferable to allow the fuel to contain this proportion of moisture. The effect of the pressure is said to be to bring the oily and tarry constituents of the peat to the surface of the block, thus giving it a coat of inflammable material, which makes the fuel readily ignitable and at the same time renders it impermeable to moisture. The size of the block is preferably about 3in. long and 3in. in diameter, each block weighing about a pound. The process is automatic throughout, the material being taken from the bog and carried through each successive operation without handling or interruption. As a consequence the manufacture proceeds very rapidly, and the raw peat is converted into dry, condensed fuel in 20 minutes from the time it is lifted from the bog. This, at any rate, is what the inventor hopes to achieve by his apparatus, which has not yet been constructed upon a commercial scale. A working model has been erected at Montreal capable of turning out 400 or 500lb. per day, which the inventor states works most satisfactorily, and has met his expectations in every way. A full set of machinery, exclusive of motive power, will cost about 6000dols., which would be capable of producing 50 tons of manufactured fuel per day of 24 hours at a total cost of 75dols., or 1·50dol. per ton, the labour of eight men being required. An engine of 40H.P. keeps the machinery in motion, and with boiler to correspond brings the whole cost of the plant up to about 10,000dols.. The machinery is placed on board a scow which floats on the bog, and being wholly under cover, can be worked in winter as well as in summer.

The superiority of the fuel manufactured by this process over that produced by nearly all others lies, according to the inventor, in the fact that the original fibre of the peat is retained intact, and with it the whole of the tarry and oily constituents, as well as the gases contained in the peat, all of which are valuable factors in the calorific power of the fuel. The retention of the fibrous condition is also an aid in the rapid drying of the peat. The trituration and grinding of the raw material characteristic of most of the older processes has the effect, it is alleged, of liberating a large proportion of the gases, which are thus wholly lost. In addition to this, the finely-divided pasty condition to which the peat is reduced in these processes renders it so tenacious of moisture that it can only be dried by applying sufficient heat to cause partial carbonisation, during which process a further loss of the tarry and volatile combustible constituents occurs.

Many experiments have been made in various parts of the world with peat, both in an air-dried and a compressed condition, as a fuel under the boilers of railway locomotives and steamship engines. It is in regular use on the railways of some of the Continental countries of Europe—for example, Bavaria, Oldenburg and Russia. It does not appear, however, to be coming rapidly into favour for this purpose, one serious defect being that, except in the best samples of condensed peat, much more space is required for stowing it than for an equivalent quantity of coal. For the same reason the cost of handling is greater and more time is needed for renewing stocks of fuel. Time and space are everything on board railway trains and steamboats, and so long as coal does not rise materially in price above its present figure it is unlikely that peat will usurp its place in the bunkers of the steamboat or the tender of the locomotive. Another objection to its use on railways is the fact that most of the varieties of peat hitherto manufactured crumble more or less upon exposure to the weather. On the other hand, the use of peat is much less detrimental to grate bars and furnaces than that of coal, and there is an absence of cinders, clinkers, and to a great degree of smoke. In 1881, 60,885 tons of peat turf were used on railways in Russia; in 1891 the quantity had fallen to 51,678 tons.

(To be continued.)

Piston Rod Packings.

Probably no specialities in engine supplies have received less attention at the hands of mechanical writers, more condemnation at the hands of engineers, or a more energetic effort at the hands of the manufacturers, than have piston-rod packings. Hence to assume the responsibility of incurring the criticism that may follow an article on this subject requires the courage to "throw down the gauntlet." But as the offering of opinions opens the way to argument, a new interest may be awakened and some benefit result to mankind generally, and possibly to those most interested in particular. Beginning with the application of steam into the first steam cylinder came also the necessity of the first stuffing-box packing of which we have any record. With this necessity came also the birth and place for an article heretofore unasked and unknown. The imprisoned power required confinement, and the piston-rod freedom of action. Upon the accomplishment of this result hinged the success or failure of the first steam engine. Through what evolutions of development it passed will be best understood when we consider the inventions now upon the market. Few, if any, of the specialities used in modern steam engineering have shown a greater diversity of ideas, of materials employed, or their arrangement. Yet all have aimed to reach the same result. The entire list of vegetable and mineral fibres has been brought into use and experimented with, as have also the various anti-friction metals. For many years the "hank" of hemp or flax was the chief dependence of the engineman. Down through the years of experiment and consequent universal adoption of steam power came the increased demand for rod packings, and with it the opportunity of the inventor to construct and

supply this want. The dawn of this new age brought with it a multiplicity of ideas more or less crude, but nevertheless useful. The laborious process of the plaiting of fibres by hand work gave forth a new result so satisfactory that it nearly superseded all other materials by its increased durability and protection of the strands. This paved the way for the construction of machinery which accomplishes the same result, and which is now kept occupied unceasingly in various manufacturing plants. With the steady increase of steam power and the demand created by it, this industry has been fostered until it has grown to a business of no small importance. Millions of dollars are annually paid by our home manufacturers, railroads, and marine trade for packings, and thousands of operatives are employed in the manufacture.

With the gradual increase of steam pressure and the correspondingly high speed of piston rods, still further improvements became necessary, and with them the natural anxiety to excel in the production of acceptable specialities. These demands were answered by the various manufacturers, and for the convenience of the user various lubricating agencies, such as tallow greases, soapstone and graphite were embodied in the fibre, and were always, and now are, a source of increased profit to the maker. When the vulcanisation of rubber became known it was here appreciated, and gradually began to be utilised in various ways to overcome the ever-present objections of rigid bearing, consequent upon the tendency of fibre to carbonise and become rigid in steam, and to further aid in adjustment in service. With this blessing of increased elasticity and the consequent increase in the durability of materials so cushioned, the variety also kept pace with the unlimited desire to compare the merits and results of each new offering.

Following in the footsteps of the earlier fibrous appliance came the metallic packings in great variety, and the gradual increase in steam pressure was again met by the many acceptable styles now offered. Their general application on rods has been hindered by the frequent non-condition of the average engine and the rapid destruction of such bearings where the alignment of rods has been imperfect. Simplicity of construction and ease of adjustment are essential requirements which should not be overlooked. Each new idea, however imperfect, will have served its purpose if only to show the necessity of overcoming a weak point. The modern engineer will not be satisfied with the conditions of the past, and the ever-varying conditions under which packings are used, as well as the unequal conditions of machinery upon which they will be tested, render it impossible to obtain a uniform result that will be accepted alike by all.

Could the designers of engines be induced to provide stuffing-boxes of ample size and depth, in order to give each class of packings an equal advantage, much trouble would be avoided. As it is, however, the selection of the most suitable packing really must be decided by the type and particular make of engines on which it is to be employed.

The great disadvantage reputable manufacturers, as well as engineers, have to contend with is the cheap product, which may look nice, but has very few wearing qualities.

The manufacturer, however, who makes the greatest effort to elevate the standard of general excellence will be repaid with an increasing business, while the substitution of inferior materials will only be continued by those who seek the cheapest markets, and the writer will predict that as the electric light has so gloriously supplanted the "tallow dip," so will the honest and intelligent improvements in this line replace the impositions that may be heralded upon the market. The time is at hand when the appreciation of durable goods will be made known, and all future requirements promptly met.

Then this line of supplies will occupy the same relative position to old ideas as does the modern Corliss engine to the first application of steam as a motive power. The successful designers and makers are men of energy, most of whom are working on advanced ideas. Their products are in the hands of the modern engineer, whose opportunities for interchange of opinion and practical experience are greater than at any previous time. Meritorious goods soon become known through their councils to all whose mission it is to use them. And as bad news always travel faster than good reports, so approaches the day when trashy products in packings will receive their sentence at the hands of an intelligent jury.—"Cassier's Magazine."

Metal Trade Memoranda.

The Mossbay Steel and Iron Company have recently obtained two or three fairly good orders for steel rails from Canada and other foreign parts.

The Jones Tinplate Company are completing their new tinning plant at Chicago. When in full work the company expect to produce 1000 boxes per week.

A new nickel steel, the secret of the manufacture of which has been secured by Herr Krupp, of Essen, has been experimented with at Meppen. Trials of guns and plates of this nickel steel have been made and have given satisfaction.

A new metal, possessing a beautiful violet colour, and having a brilliant appearance, has been discovered by Dr. Purcell Taylor. It has a high melting point, and is hard and crystalline. The specific gravity of the new metal is 8·2, and it is said that its cost will be high. Dr. Taylor has named the substance farmanium.

The Ynisecdwyn Tinplate Works, Ystalyfera, have been acquired by a syndicate of London capitalists. It is stated that the new proprietary is contemplating the erection of Bessemer steel plant and mills for the manufacturing of tinplate bars on the adjoining property, which has already been leased by the company.

Official Gazette.

Partnerships Dissolved.

G. Spencer and A. H. M. Jones, under the style of Spencer and Jones, Ashton-under-Lyne, engineers, machinists, and millwrights.

R. Reader and P. Reader, under the style of E. Reader and Sons, Nottingham, engineers and machinists.

THE BANKRUPTCY ACTS, 1883 and 1890.

Receiving Order.

Francis Pilkington, Redhill-street, Albany-street, N.W., iron merchant.

The Metal Market.

PRICES CURRENT.

LONDON, Feb. 27.

Copper began 1s. 3d. lower with a steady tone, cash being done at £45 10s., but rallied sharply on an active cash demand to £45 12s. 6d., 400 tons being taken at this figure. A quieter tone supervened when the orders had been filled, £46 being taken for three months. £45 11s. 3d. for cash, £45 16s. 3d. for middle, and £45 15s. for early April. The close is steady at a partial rise of 1s. 3d. Sales, 900 to 1000 tons, the greater part being for prompt delivery. Settlement price, £45 10s. English tough, £48 15s.; best selected, £49 10s. to £50; strong sheets, £56 10s. to £57.

Tin was steady and unchanged at the opening, with sales of three months at £92 17s. 6d. The market afterwards improved to £92 15s. for six weeks, and later on cash changed hands at £93 to £92 17s. 6d., and three months and a week short at £93 5s., the end of June meanwhile passing at £92, and the middle of August at £90 10s. Towards the close, however, on the news of the institution of an inquiry by the American Senate concerning the duty to come into force next July, the market became weak, three months passing at £92 12s. 6d., and after the official close cash was offered at £92, with buyers at £91 17s. 6d. Final rates are quiet and 7s. 6d. to 10s. lower. Sales, 130 tons. Settlement price, £92 12s. 6d. English ingots, £95 10s.

Pig Iron has ruled inactive, early bids of 41s. three months and 40s. 6d. being allowed to pass. These were not repeated, and the close was easy at 5d. decline, Middlesbrough being 1½d. down, but hematite 3d. up. Settlement prices:—Scotch, 40s. 7d.; Middlesbrough, 34s. 3d.; hematite, 45s.

Tinplates dull at quotations. I.C. cokes, f.o.b. London, 12s. 7½d; Liverpool, 12s. 1½d.; Swansea, 11s. 7½d.

Lead is steady at late rates. Spanish, £9 7s. 6d. sellers, £9 5s. buyers; English, £9 10s.

Spelter has ruled firm at £17 7s. 6d. sellers, with buyers at £17 5s.

Zinc Sheets.—Silesian is 2s. 6d. better, in sympathy with spelter, at £20 5s. ex ship, sellers. Belgian steady; V.M. brand, £20 17s. 6d., ex ship, and £20 15s. f.o.b. Antwerp.

Official Closing Quotations.

	To-day.					
	£	s.	d.	£	s.	d.
Copper—						
G. M. B.—Cash	45	11	3—	45	18	9
" Three months	46	0	0—	46	7	6
Tin—						
Fine foreign—Cash	92	12	6—	93	2	6
" " Three months	92	12	6—	93	2	6
Australian—Cash	93	2	6—	93	12	6
Pig Iron—					s.	d.
Scotch warrants—Cash					40	7
" One month					40	9
Middlesbrough—Cash					34	3
" One month					—	
Hematite—Cash					45	6
" One month					—	

GLASGOW, Feb. 27.—Business was quiet on the pig-iron market, and Scotch was freely offered at the forenoon session, 15,000 tons being done chiefly for cash from 40s. 11½d. to 40s. 9½d. At the afternoon market, with no cash buyers, the sellers' price gave way 2d., while some month dealing took place at the forenoon's cash figures. A thousand tons of hematite sold on forward account at 45s. 6d., and 45s. 3d. three months fixed with 2s. forfeit in sellers' option. The shipments of Scotch last week were 4191, being a decrease on the corresponding week of 734 tons, thus making the decrease for the year 7936 tons.

Quotations:—

	Scotch.		Middlesbrough.		Hematite.	
	Cash.	1 m'th.	Cash.	1 m'th.	Cash.	1 m'th.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Highest	40 11½	—	34 3	—	45 6	—
Lowest	40 7	—	34 3	—	45 3	—
Close	40 7	—	34 3	—	45 6	—
Prev. close	41 0	41 0	34 4½	—	45 3	—

New Companies.

Britonferry Tinplate and Decorating Company Limited.—This company was registered on the 18th ult., with a capital of £6000, in £6 shares, to carry on the business of iron, steel, terne, decorated, and black plate, and galvanised sheet manufacturers and merchants, and all subsidiary businesses. Registered, without articles of association, by Charles Doubble, 14, Serjeant's Inn, E.C.

Birmingham Metal Stamping Company Limited.—This company was registered on the 21st ult., with a capital of £9000, in £1 shares, to report and carry into effect an agreement made on the 18th ult. between E. Hauff and Robertson Buchanan Moncrieff Stewart, carrying on business as the Birmingham Metal Stamping Company, of the one part, and F. Stevens, as trustee on behalf of the company, of the other part; and to continue the business of the Birmingham Metal Company, as carried on by them at 50, Pentonville-road, Islington. Registered, without articles of association, by H. S. Bridge, 14, Union-court, Old Broad-street, E.C.

Dafen Tinplate Company Limited.—This company was registered on the 22nd ult., with a capital of £25,000, in £50 shares, to adopt and carry into effect an agreement made on the 20th inst., between S. J. Phillips, R. Maclaran, and David John, jun., and to carry on all or any of the trades of manufacturers of iron, steel, tin, terne, and black plates, decorative tinplates, and other articles of a similar nature, ironmasters and founders, chemical manufacturers, electric lighters, colliery proprietors, and brick, pipe, and tile manufacturers and merchants. The number of directors is not to be less than 3, nor more than 5; the first being R. Maclaran, D. John, jun., and Martin John, all of Llanelly; qualification, £100; remuneration to be fixed in general meeting. Registered by Jordan and Sons, 120, Chancery-lane, W.C. Registered office, Dafen, Llanelly, Carmarthen.

British Engineering Company Limited.—This company was registered on the 20th ult., with a capital of £20,000, in £1 shares, to purchase or otherwise acquire any patents, trade marks, and the like, conferring any right to use any invention or trade name which may seem to the company capable of being profitably dealt with; to enter into an agreement made between William Fraser, of Birmingham, and G. Chapman, of Birkenhead, of the one part, and H. Clarke, of Liverpool, of the other part; and to carry on the business of mechanical engineers, smelters, iron and brass founders, and metal workers. The number of directors, until otherwise fixed, is not to be less than 3, nor more than 7; W. Morton, J. Thorburn, A. H. Chalmers, W. Fraser, and J. S. Chapman being the first; qualification, £100; remuneration to be fixed hereafter. Registered by G. Thatcher, 32, Essex-street, W.C.

William Houghton and Co. Limited.—This company was registered on the 16th ult., with a capital of £10,000, in £10 shares, to purchase and take over as a going concern the undertaking and business carried on by William Houghton and Co., as engineers and millwrights, at Great Grimsby, in Lincoln, together with the goodwill, patents, stock-in-trade, materials, goods, chattels, effects, machinery, plant, tools, fixtures, book-debts, assets, trade debts, and liabilities; to continue to work and otherwise deal with the properties so acquired, and to carry on the business of agricultural and general engineers, machine and implement makers, mechanical engineers, ironmongers, colliery proprietors, and other similar undertakings. With very few alterations the regulations of Table A apply. Registered by Williamson, Hill and Co. 13, Sherborne-lane, E C.

Miscellaneous Items.

The new pier of the Inman Steamship Company at New York will be 700ft. long, and will have a two-storey shed, built of iron and steel.

The Admiralty has decided to complete the erection of land forts for the protection of the approaches to London and the Chatham Dockyard. A fort is also to be built about two miles from Chatham in the Dover-road, at a cost of £70,000.

The total train mileage of the London and North-Western Railway during the half-year ending December 31, 1892, was:—Passenger, 11,819,617 miles; goods and minerals, 10,678,807, or a total of nearly 22½ million miles. The total cost of locomotive power for this was £828,126 14s.

Experiments are to be made with a light brick for interior partitions, ceilings, and other places where crushing strength is not required. With ordinary clay and sand about 50 per cent. of fine sawdust will be mixed. The brick will be moulded under heavy pressure, and then burned until the sawdust is consumed.

To accommodate the growing demand for cool space in the mail steamers from Australia for the conveyance of fruit, chiefly Tasmanian apples, the Orient Company have recently made large additions to the refrigerator holds of the Orient Line steamers which will be leaving during the next fruit season. The first of these, the twin-screw s.s. "Ophir," is due to reach England about the middle of April.

The death is announced of Mr. Percy Everitt, at New York. He was the inventor of the "penny-in-the-slot" machines.

A further development of the letter-card has recently been patented in France and other countries in the Postal Union by Mr. F. M. Merridew, Boulogne. The invention, which, it is understood, has been submitted for the consideration of our postal authorities, is practically a combination of the letter-card and the reply postcard, introduced some few years ago, with the advantage, however, that the lack of privacy which is the chief drawback in the postcard system is now obviated. The new card consists of two separate sheets of paper, each designed on the model of the letter-card, with gummed edges and perforations. In the outer sheet, bearing the sender's message, is contained the second sheet of somewhat smaller make. This is intended for the reply, and has only to be gummed up, addressed, and sent through the post like the ordinary letter-card.

Prize Competition.

We offer Four Guineas monthly in prizes for the best original articles sent in on any Mechanical, Engineering or Electrical subject.

In order that Managers, Draughtsmen, Foremen, and Workmen who have had no practice in writing may not hesitate to send in competitions, it is to be understood that all articles will be fully edited and corrected, and judged of solely on their merits as original contributions from a practical point of view. The object of the competition is to induce practical men to come forward and give the results of their experience.

CONDITIONS.

Competitions for our Monthly Prizes must be sent so as to arrive at the Manchester Offices of The Mechanical World, New Bridge-street, not later than the last Tuesday in each month. Articles arriving after that time will be placed in the following month's competition.

Written competitions must be on one side of the paper only. The contributions must be original, and relate to matters connected with Engineering, Mechanism or Electricity.

The Proprietors of The Mechanical World reserve the right to publish any competition, whether it gains a prize or not.

The competitions may be accompanied by diagrams, sketches or drawings.

Competitors should write the words "Prize Competition" on the envelopes.

Competitors are not confined to one, but may send any number of competitions.

The correct name and address of the sender *must* be distinctly written upon every competition, not necessarily for publication. Competitions can appear under a *nom de plume*.

☞ We cannot undertake to be responsible for any MSS. sent to us, though when stamps are enclosed for the purpose we will endeavour to return rejected contributions.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

Iron Manufacture.—Required, particulars of the Husgafel process of making iron blooms direct from the ore.—F. C.

Twist Drill Cutters.—Can any reader give me a method of getting the correct thickness and shape of cutter for any diameter of twist drill, straight lip? A drawing will greatly oblige.—J. M. F.

Engineers' Wages.—Would any reader kindly give me some information as to the wages at Cape Colony and Mexico for mechanical engineers?—Regular Reader of "The Mechanical World."

Rust Joints.—How can I stop leakage in a vertical joint (rust joint) in my hot-water pipes (low-pressure system) without cutting out the packing? Would any fluid cement percolate into the crevices and harden there?—B.

Makers of Builders' Ironwork.—Can any reader furnish me with addresses of firms who are makers of machinery for making builders' ironwork, such as bands and hooks, cavity irons, etc.?—Smith.

Condensers.—Will any reader kindly inform me how to calculate the cooling surface and air-pump capacity required for an outside condenser for a steam launch? Double-cylinder simple engines; cylinders, 4½in. diameter by 5in. stroke; 200 revolutions per minute; 100lb. pressure per square inch; 8I.H.P.?—A. I. C.

Locomotive.—Will any reader of The Mechanical World kindly give me the best way to trammel a locomotive which has too much play in the axle boxes and more on one side than the other? There are no centre marks on the crankpins.—Dubbs.

Electric Trolley.—I am in want of a trolley to carry about 3 tons a short distance on a good road nearly level. Can I get one to be self-propelling, and what would be the best kind of motor? I shall be glad if any reader can inform me where anything of this kind can be seen.—Corn Miller.

Boiling Coppers.—What is the grate area required to boil five 100-gallon coppers and one 50-gallon copper? Said coppers are steam jacketed; inside of copper, outside of wrought iron; boiler pressure 80lb., reduced to 7lb. before reaching coppers. Will be glad of rule for calculating above.—S. Haywood.

Conveying Device.—I want to remove cut straw, ⅜in. long, from chaff cutter to a room distance 60ft., round one curve, at the rate of 5 tons per hour. What size tube shall I require, and how can I do it by means of a blast fan so that the chaff does not go through the fan? Would sanitary tubes do for the purpose, underground?—Puzzled.

DISINFECTANT.—Will any reader kindly tell me how to make a cheap and effective disinfectant powder?—BOILERS.

DYNAMO SHAFT.—I should be much obliged if the author of "The Design and Construction of Stationary Engines," or some other reader, could give me a formula (or refer me to any book where I could find it) for arriving at the size of shafts for dynamos and motors; given distance between bearings, weight of armature and pull on periphery of same in lb. Any information with respect to this would be much appreciated.—A YOUNG ELECTRICAL ENGINEER.

EXHAUST STEAM.—Could any of your numerous readers give me any information as to how to dispose of exhaust steam from a donkey feed-pump, and say if it would be right to put the exhaust steam into the feed-water on the suction side, and what arrangement is required for this? The water is at present 80° F., and the pump has to lift it 12ft. Will the pump work satisfactorily if the exhaust steam be put into water at 80°.—INJECTOR.

PUMPING PLANT.—Wanting to lay down a pumping plant to pump 60,000gals. of water per day of 10 hours from a shaft 240ft. deep, I should be glad if some reader would answer the following questions. (The arrangement is similar to that shown in THE MECHANICAL WORLD for July 15, 1892, only plunger lift instead of jack-head preferred.) (1.) Diameter and length of stroke of plunger. (2.) Size of engine required, having due regard to fuel economy, coal costing about 16s. per ton. (3.) Sizes and proportions of wheel gearing. (4.) What amount of coal per day of 10 hours should be consumed, assuming the coal to be of fair quality?—J. P.

FEED-WATER HEATERS.—Would someone kindly inform me how to calculate and give all particulars of a plain wrought-iron vertical or horizontal cylindrical feed-water heater; number of tubes, diameter, and heating surface, height and diameter of wrought-iron cylinder, and whether brass or wrought-iron tubes would be best, for an engine with 16in. cylinder by 2ft. 3in. stroke, making 70 revolutions per minute? Steam pressure, 60lb per square inch; cut-off at ⅝ stroke; size of exhaust pipe, 5in. diameter; steam pipe, 4in. diameter; exhaust steam to pass through heater tubes. How much larger would heater have to be for a pair of engines with cylinders as the one above?—FEED WATER.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

J. HOWARD.—No address given.

AMATEUR.—You can only test it by trial.

YOUNG BEGINNER.—See reply to J. Howard.

BRASS.—Apply to the Mansfield Woodhouse Sand Company, Mansfield.

BOILER.—We think we can supply you with a copy if you require one.

GLAMORGAN.—The slide-valve type is found to keep tight longer under pressure.

ENGINEMAN.—It is generally mixed. Apply to Messrs. Bell's Asbestos Company.

P. B. R.—You will find a full illustrated description in our issue for July 5, 1890.

THOS. SMITH.—It is said that if pure soft water is used the tools will not chip. Try this.

YOUNG BEGINNER.—The subject is dealt with at length in Hopkinson's book on the Indicator (9s.).

B. G. N.—We should think Phillip's "Engineering Chemistry" would suit you. Price 10s. 6d., from our office.

MARINE.—Yes, we believe so. Inquire of the Assistant-Secretary, Marine Department, Board of Trade, Whitehall, London.

C. M. MINISTER.—Your query is not very explicit. If you will explain precisely what you require, we will do our best to help you.

C. A. LEE.—We should think Professor Ripper's "Machine Drawing and Design" (25s.) would suit you. There is no good English work on locomotive design.

THOMAS T. SIMS.—We think it quite possible that, under the circumstances named, the young man would become a very fair draughtsman in the time specified.

O. P. MASON.—We would advise Rankine's "Machinery and Mill Work" (12s. 6d.); Cotterill's "Applied Mechanics" (18s); and Jamieson's "Steam Engine" (7s. 6d.).

APPRENTICE.—Apply to the secretary, 9, Westminster Chambers, Victoria-street, London, S.W. The only advice we can give you is to write to several firms offering your services.

J. ROBERTSHAW.—We think you will find it a difficult task to do what you propose. We would advise you to apply to Messrs. J. Sagar and Son, of Halifax, who will, we think, be able to assist you.

J. MAXWELL.—Your first question is out of our province. You cannot solder aluminium successfully in the way you suggest. A special solder is supplied by Mr. W. A. Briggs, East Dock-street, Dundee.

GEARING.—Yes; your sketch shows the manner of measuring the diameter correctly. The price of the book referred to, and which you may have from our office, is 6s. It is the best we know of for your requirements.

HOT BEARING.—You do not say what work the engine has to do. See "Mechanical World Pocket Diary" for 1893, pp. 70 and 71. Read also the articles on "Design and Construction of Stationary Engines," now appearing in these columns.

A STUDENT.—A machine may be considered as consisting of a number of parts capable of moving relatively to each other in some well-defined manner. Each part forms an element of two consecutive pairs, and serves to connect the pairs, so that the whole mechanism may be described as a chain, of which the parts form the links. This series of connected pieces is called a kinematic chain. Read Cotterill's "Applied Mechanics," or Prof. Kennedy's translation of Reuleaux's "Kinematics of Machinery."

M. MURPHY.—To give a satisfactory answer we ought to know the number of revolutions the engines are intended to run, and the indicated horse-power required. In marine practice a great deal of difference of opinio exists as to the sizes of boilers for given engines. An approximate result may be arrived at in the following way:—We require first to know the quantity of water it will be necessary to evaporate in any given case. For a compound engine this can be found sufficiently near as follows: Multiply the area of the low pressure cylinder in square feet by the piston speed in feet per minute, and by 60 = the cubic feet of steam used per hour; this divided by the specific volume of the steam at terminal pressure (say 10lb. absolute, specific vol. 2363) = the cubic feet of water required per hour. This result multiplied by 62 (the weight of a cubic foot of water in lb.) and divided by 8 (water evaporated by 1lb. of coal per hour), and this result again divided by 20 (number of lb. of coal consumed per square foot of grate per hour) = the number of square feet of grate surface required. In this calculation no account is taken of the rate of expansion in the example given. Assume piston speed as 450ft. per minute, we have then $\frac{450 \times 11{\cdot}5 \times 60}{2363} \times \frac{62}{8 \times 20}$ = say 51 sq. ft. Add, say, 10 per cent. extra to allow for loss and any increase of power which may be required; or, say, 56 sq. ft. of grate surface. The ratio of heating surface to grate surface varies in marine practice from 28 to 35 times. Suppose we allow an average of 32 sq. ft. We have then 32 × 56 = 1792 sq. ft. of heating surface required. To give this heating surface and grate area would require a boiler 14ft. dia. by 10ft. 6in. long, having three 40in. furnaces. We may arrive at the result in another way. Assuming, as before, the piston speed is 450ft. per minute, we may assume that the mean pressure referred to the lower-pressure cylinder will be about 32lb. per sq. in., and the power developed by this pressure about 660I.H.P. A very common allowance of grate surface is 1 sq. ft. for every 12I.H.P. We have then $\frac{660}{12}$ = 55 sq. ft. of grate surface, and allowing the same rates of heating surface we should have 55 × 32 = 1760 sq. ft. of heating surface—a result not differing much from that given above. If one large boiler as specified were not desirable, two boilers 10ft. 6in. diameter by 9ft. 6in. long, each having two 36in. furnaces, might be used, and they would give a rather higher aggregate heating surface and grate surface, but the excess would err on the safe side. It is better policy to have the boilers ample in size.

FILTRATION.—Will any reader state the best method of filtering 150gals. of canal water per day for steam-boiler purposes?—T. H. MITCHELL.—*A.*—The best method depends entirely upon the various conditions, which you should have given, such as degree of turbidity, chemical impurities in water, relative levels of boiler-house and canal, etc. If you have a moderate amount of land to spare, probably a simple pair of settling tanks would answer, one to be filling and settling while you are pumping from the other. Make experiments on a tank or large vessel to see in what time the water clears itself by settlement to a depth of say 2ft. This will enable you to estimate the time the water must remain at rest in each reservoir, and from this you can find the necessary size of each. Probably a pipe, with its suction end floating about 6in. below surface, would be the best method of collecting the pure water. The cheapest filter would be an ordinary sand one, the sand to be 2ft. to 3ft. deep and the water running through at the rate of about 3gals. per square foot per hour. If the water was to be filtered as quickly as used this would mean $\frac{150\text{gals.}}{9\text{ hrs.}}$ = 16·6gals. per hour. $\frac{16{\cdot}6}{3}$ = 5·5 sq. ft. area of filter. Probably for such a small amount it would be safer to make the filter larger, say 8 sq. ft. area, giving a rate of filtration of 2gals. per hour per square foot. In either case it would be worth while to remove the lime, or "soften" the water before filtering or settling if it contains much, as this would diminish, if not almost stop, scale in the boiler. This may be done by Clark's process, which consists in mixing limewater with the water to be purified. About ½lb. of quicklime is required per 1000gals. of water, and about 10 per cent. of the total water softened must be used to slake this lime and make limewater. This mixture is then either run into settling tanks or the precipitate is removed by filtration.—T. J. B.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

13th February, 1893.

3131 TUBULAR BOILERS. H B Piper.

3133 TOOL for BORING TAPER HOLES. F H Clarke and A R Hart.

3143 SMOKE CONSUMING APPLIANCES for STEAM BOILER FURNACES. W Crowther and others.

3145 STEAM GENERATOR FURNACES. G Petrie and J K Needham.

3146 DIAPHRAGMS for TELEPHONES. G L Anders and W Kottgen.

3147 STEELYARDS for WEIGHING COALS and OTHER SUBSTANCES. C H Bartlett.

3149 PROCESS and APPARATUS for AUTOMATICALLY EXTINGUISHING FIRES. J Longshaw.

3152 ELECTRICAL PENDULUM INDICATOR. E Beal.

3166 ROLLING PARALLEL RULE and MATHEMATICAL SCALE. W Coulsell.

3171 APPARATUS for CASTING PIG IRON.* H D Hibbard.

3174 REDUCING PRESSURE VALVES. D Gilson.

3175 HOLDERS for DRILLING, TAPPING, and SIMILAR TOOLS. W Payton.

3185 APPARATUS for RECORDING and REPRODUCING SOUNDS. J R Quain.

3181 ROLLERS for RECIPROCATING RODS, such as those which WORK RAILWAY POINTS or SIGNALS. E Charrington.

3183 PRODUCING VACUUM in STEAM ENGINES. M H Robinson.

3189 STEAM GENERATORS. M H Robinson.

3193 NOVEL SELF-ADJUSTING LEVELLING INSTRUMENT. H Blackham.

3197 RAILWAY SIGNALLING APPARATUS. J Rice.

3199 MANDRIL for BENDING METAL TUBES THEREON, in the MANUFACTURE of MUSICAL INSTRUMENTS. C J E Smith.

3200 FIXING ELECTRIC CONDUCTING WIRES to the INSULATORS SUPPORTING SAME.* P R Schomburg.

3206 CHAINS for TRANSMITTING POWER. H H Lake. (*J O Brown*, United States.)

3210 PRIMARY BATTERIES and MINERS' and LIKE PORTABLE LAMPS. S W Maquay.

3211 RAILWAY and TRAMWAY LOCOMOTIVES. J J D Cleminson.

14th February, 1893.

3213 MAIN WATER SERVICE REGULATOR. T H Griffiths.

3215 BILGE FEED or CHECK VALVE. T Dickinson.

3218 MEANS of STRENGTHENING METAL PIPING. G W Fox.

3220 NAILS. R W Bateman.

3224 RETORTS USED for the DESTRUCTIVE DISTILLATION of CARBONACEOUS SUBSTANCES for the PRODUCTION of MINERAL OIL and AMMONIA. A C Thomson.

3225 TELEPHONIC TRANSMITTERS. A Marr.

3230 GROOVING, MITREING, and CHAMFERING MACHINE for CUTTING V GROOVES and MITRES. C H Wood.

3240 TRENCHING TOOL. E North.

3257 LOCK NUTS.* G C Richards and C G Hainline.

3263 WORKMEN'S TIME RECORDERS.* G W Heene.

3273 LOCOMOTIVES WORKED by COMPRESSED AIR.* O Imray. (*J Kames*, United States.)

3274 ELECTRICAL TRANSFORMERS. W C Johnson and S E Phillips.

3281 ROCK DRILLS. J H and J M Holman.

3284 QUICK-ACTION ADJUSTABLE WRENCH or SPANNER. H Fairbrother.

3285 ELECTRIC SIGNALS.* F H Clarke.

3287 RATCHET WRENCH. G N Hupp and others.

3298 ARTIFICIAL FUEL. T Price and T S Payne.

3299 EDGE RUNNER CRUSHING or GRINDING MILLS. J H Hind.

3301 AUTOMATIC AERIAL RAILWAYS.* H W Libbey.

3311 ASH EJECTORS for STEAMSHIPS.* G Clarke.

3317 RAILWAY COUPLINGS. T E W Fay.

3318 SAW FRAMES.* J Gelardin.

15th February, 1893.

3326 VALVE. M A Brookes.

3332 GAS ENGINES. J W Hartley and J Kerr.

3337 APPARATUS for EVAPORATING LIQUIDS by MEANS of STEAM. D B Morison.

3342 GAS ENGINES. J W Hartley and J Kerr.

3343 FEED-WATER HEATERS for STEAM BOILERS. W Shore and G Coupe.

3345 IRON and STEEL for the MANUFACTURE of ARMOUR PLATES and PROJECTILES. G B Ellis.

3346 APPLICATION of ELECTRIC MOTORS for DRIVING SEWING and OTHER LIGHT MACHINERY. F Brown.

3354 SIGNALLING APPARATUS for USE on RAILWAYS. W Grimes.

3367 CROSS-BARS for the DOORS of HAND and MAN HOLES of BOILERS.* J Partington.

3369 END THRUST, ROLLER, and BALL BEARINGS.* F Purdon and H E Walters.

3370 CONTROLLING RAILWAY SIGNALS. W R Sykes, jun., and J P O'Donnell.

3372 ENGRAVING MACHINES. T Essig.

3376 DIRECT CURRENT DYNAMO MACHINES. J S Fairfax.

3378 SIGNALLING TRAINS.* J T Sanders and J Hayter.

3385 MICROMETER GAUGE. J P Lavinge and W F Day.

3387 UTILISATION of ELECTRICITY for HEATING PURPOSES. J R Quain.

3389 COMBINED APPARATUS for BURNING REFUSE. J J Miller.

3391 RAILWAY SIGNALLING APPARATUS. F Harvey and others.

3396 STEAM and OTHER MOTIVE FLUID ENGINES. W C Church.

3398 INSULATING MATERIAL for ELECTRICAL PURPOSES. A Gentzsch and others.

3399 SIMULTANEOUSLY WASHING COALS SORTED INTO VARIOUS SIZES with REPEATED USE of the WASHING WATER. F Baum.

3401 GAS ENGINES. D Davy.

3402 ELECTRIC METERS. W Clark. (*The Firm of Hartmann and Braun*, Germany.)

3403 APPARATUS for CLEARING the GROOVES of TRAMWAY RAILS. A B Gil.

3408 SEMI-AUTOMATIC LUBRICATORS. F Trier and G W McQuaker.

3412 TRANSMITTING TELEGRAPHIC SIGNALS THROUGH SUBMARINE and LIKE CABLES. A Muirhead and H A C Saunders.

3423 RECORDING INSTRUMENTS for ELECTRIC TELEGRAPHS. A Muirhead and R H Edgar.

3418 RIVETING MACHINES for RIVETING CARDBOARD, LEATHER, FABRIC, or the LIKE.* A J Boult. (*E Saltzkorn* and *L Nicolai*, Germany.)

16th February, 1893.

3423 APPARATUS for EFFECTING the CONSUMPTION of SMOKE in STEAM-BOILER FURNACES. J and E A Green.

3424 BARLESS CIRCULATING FURNACE for STEAM BOILERS. W Freakley.

3432 APPLIANCES for BURNING OIL in STEAM BOILER and OTHER FURNACES. A Stewart and others.

3442 COMBINATION LEVEL, BEVEL, and SQUARE. E Martin.

3447 STEAM and LOW-WATER SAFETY VALVES.* A Turnbull.

3448 STEAM GENERATORS. H Campbell and J C Jopling.

3456 STEAM BOILERS and BOILER FURNACES. C A Knight and G W Thode.

3462 VALVES. C K Welch.

3463 COMPOUND ENGINES. C A Ball.

3470 ELECTRO-MOTORS and DYNAMOS. J A Kingdon.

3476 APPLIANCES for CHECKING WORKMEN'S TIME. J Jofeh.

3477 CONSTRUCTING and CONNECTING GALVANIC ELEMENTS. H Nehmer.

3484 APPARATUS for RETURNING CONDENSED WATER to BOILERS UNDER PRESSURE. T Andrew.

3486 RADIAL TUBE or PORCUPINE STEAM BOILERS.* E S T Kennedy.

3488 TELEPHONES. Sir C S Forbes, Bart.

3489 APPARATUS for LOCKING and UNLOCKING MINERS' SAFETY LAMPS. M Wolstenholme.

3503 PURIFICATION of METALS in THEIR MOULDS. E Taussig.

17th February, 1893.

3507 NON-CONDUCTING COMPOSITION for RETARDING the RADIATION of HEAT from BOILERS, PIPES, and CYLINDERS. G C Douglas. (*W Don* and *T Watson*, India.)

3509 INSTANTANEOUS GRIP VICES. J Appleyard.

3510 GEAR WHEELS. E Barnes and J Garrison.

3511 PERFECTLY SAFE BACK-BOILER VALVE. E C Howkins.

3512 GOVERNORS for STEAM or OTHER FLUID PRESSURE ENGINES. G Love.

3515 APPARATUS for AUTOMATICALLY REGULATING or ADJUSTING and MAINTAINING the TENSION of SIGNAL or OTHER LINE WIRES. J G Dixon.

3518 APPARATUS for PREVENTING COLLISIONS on RAILWAYS. J Orme.

3519 APPARATUS for MAKING TUBES or CYLINDERS of STEEL or LIKE METAL. W and J Crawford.

3527 APPARATUS for FORGING CIRCULAR IRON or STEEL BALLS. J Hudghton.

3528 EXPANSION VALVE-GEAR for STEAM ENGINES. J T Douglas.

3530 HEATING, by EXHAUST STEAM, WATER for FEEDING STEAM BOILERS. G Gowan.

3550 CAPSTAN and OTHER SIMILAR ENGINES. B Shaw.

3552 COMBINATION WRENCHES.* W P Thompson. (*H A Post* and *F W Wright*, United States.)

3554 PREPARING PEAT for HEATING, GAS GENERATING, and OTHER PURPOSES. T A Dillon.

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FRIDAY, MARCH 10TH, 1893.

Electrical Legislation in Germany.

IN recent years complaints have been made in Germany that the details of Bills proposing to legislate on questions of considerable importance to the country at large have been kept secret until the moment they are introduced into the Imperial Diet, and that if their passing is hastened, as often happens, those directly concerned find it impossible to express their opinions and impart their technical knowledge on the subjects at issue. This is detrimental in many cases to the industries concerned, and this policy seems to amount to the Government not receiving (with the exception of from its own officials) expert opinion from the trades interested. This policy was not pursued a few years ago, as, for instance, in the case of the Patent Act; but it is now very largely followed. The German Electric Light and Power Bill, to which reference was made on a previous occasion, is embodied in the present policy. After slumbering on the table of a committee of the Federal Council for a year and a half, the Bill has been rushed through the Federal Council, and is, it seems, to be similarly treated in the Imperial Diet, before which it has just been laid. The Electric Light and Power Bill was proposed a few years ago simultaneously with the then Telegraph Bill; the latter, being passed with undue haste, has never satisfied either the Government or the traders of the country. The former, postponed at the time, is, as an Act, to be so framed as to meet the deficiencies of the Telegraph Act. The Electric Light Bill as set forth is said to be neither necessary nor useful, and the concensus of opinion of the speakers, including many well-known German electrical engineers, at a meeting of the Berlin Society of Engineers last month, was to that effect. It is, moreover, contended that the Bill, if it becomes law, will seriously hamper the electrical industries. There is reason to suppose that the Bill, which really contains many unnecessary regulations, and which is now before the Upper House, will be passed, notwithstanding the protests of a large section of the electrical trades of the country.

Mannesmann Boiler Tubes.

FROM a statement made in one of our Continental contemporaries, it would appear that the Austro-German Mannesmann Tube Works have gone into the manufacture of locomotive boiler tubes by the Mannesmann process on a large scale, and with satisfactory results. At the beginning of last year the Royal Railroad Commissioners at Berlin began a series of careful tests of the physical properties of tubes for locomotive work, and, on the strength of the results obtained, have not only concluded to henceforth fit up all their new locomotives with these tubes, but have also given heavy orders for Mannesmann tubes to be used for renewals. As a rather interesting and noteworthy novelty recently introduced in the manufacture of the tubes, it is stated that, while the tubes are of uniform outside diameter, they are made with the inside diameters varying from end to end, giving a tapering interior, and a consequently greater thickness of the tube walls at one end than at the other. Advantage is to be taken of this feature by placing the tube ends with the greater weight of metal toward the firebox end of the boiler, where there is apt to be most wear. At the smokebox end, then, there would be less tube thickness, which, it is argued, would be conducive to a better utilisation of the available heat of the cooler products of combustion.

A New Central Station.

IN developing the adoption of the electric light in London, the Metropolitan Electric Supply Company may now be considered to have done more than any other single company. Starting with the acquisition of the Whitehall-court generating station, the company has rapidly built others in Rathbone-place, Sardinia-street, Manchester-square, and at Paddington, the latter being opened on Friday last, when the members of the Paddington Vestry and others were shown over the station. The company has not confined itself to one particular type of generating plant. Thus, for instance, the Sardinia-street station is equipped solely on the Westinghouse high-tension system, and is the only works in this country where that method is used. The high-pressure system is also used at Rathbone-place and at Manchester-square; but in the latter case high-speed engines coupled direct to alternators, are in operation. At the Paddington depôt there are five horizontal engines driving Kapp alternators by means of ropes. The total generating plant of the whole of the stations is capable of energising incandescent lamps equivalent to 130,000 of 8C.P., and at present the Metropolitan Company supplies more lamps than any other company. By adopting different types of generating plant valuable experience is gained, which is of immense utility in extending existing or erecting new stations, as, for instance, that to be built at Waterloo Wharf. An interesting comparison would be the cost of producing a Board of Trade unit at each of the stations.

A Novel Dredger.

THE dredging operations carried out by the Mersey Dock and Harbour Board in cutting a channel through the Mersey bed, have proved so satisfactory that it has been decided to extend the work in order that steamers of the greatest tonnage may be enabled to enter the river at any state of the tide. For this purpose a dredger, said to be the largest in the world, was designed by Mr. A. G. Lyster, and built by the Naval Construction and Armaments Company, of Barrow. The vessel is of the following dimensions:—Length between perpendiculars, 320ft.; breadth, moulded, 46ft. 10in.; depth, moulded, 20ft. 6in.; gross register tonnage, 2560 tons. She is built of steel to Lloyd's highest class, and has amidships eight large hoppers, four on each side of the vessel, having a total capacity of 3000 tons of sand. A well is formed up the centre of the ship, between the hoppers, to allow the working of a sand-pump suction tube, 3ft. 6in. diameter, through the bottom of the vessel. This tube is raised and lowered by hydraulic power, and when lowered can dredge to a depth of 45ft. Two large centrifugal pumps, having suction and discharge pipes 3ft. in diameter, capable of raising 4000 tons of sand per hour, are driven by two sets of triple-expansion engines. The vessel will be able to fill her hoppers with 3000 tons of sand, to proceed to the depositing ground, and to get back again to the scene of operations in one hour.

An Electric-light Contract.

IT is proposed to establish a central electric-light station at Liège, Belgium, and tenders are now invited by the Administration Communale for the erection and working of the generating depôt. The choice of the system best suitable for the town is left to the consideration of intending competitors, who must furnish to the authority mentioned complete schemes, together with plans and estimates, at the same time sending a deposit of £2000. The concession, which will be for 25 years, gives the exclusive right to lay feeding and distributing mains either underground or to carry them overhead. The maximum charge for current must be stated to the Administration Communale of Liège, from whom further particulars may be obtained. One English firm having recently obtained a fairly good order from another Belgian town, there seems no reason why the proposed Liège central station should not also be equipped by a British firm.

Austrian Electric Railways.

THE Viennese have for some years advocated the establishment of a metropolitan railway, and although various proposals have been made in this direction, no material steps have been taken to accomplish the object in view. It is, however, expected, now that electric railways are projected in Vienna, that the Government will be induced to consent to the building, on one system or another, of the long-talked-of metropolitan line. In this connection it is worthy of note that the Anglo-Austrian Bank, in conjunction with Messrs. Siemens and Halske and the General Austrian Electricity Company, has approached the municipality with a detailed scheme for the construction of an electric railway to encircle the inner town, and a branch line to pass through the inner part of the town. The ring line would commence at the Praterstern, and terminate at the crossing of the Schwarzspanier-street by the Wahring-street, although it would eventually be extended to the Danube Canal. Specially interesting is the fact that, if a concession is granted for these lines, they would be laid down on the slotted conduit system, which has yielded good working results at Buda-Pesth. Siemens and Halske are to be the contractors, and the current is to be provided by the General Austrian Electricity Company, which has just completed its second large central station in the Leopoldstadt district. Another scheme—this, however, concerning Buda-Pesth—for an underground electric railway in that city, has been abandoned by the promoters, Messrs. Siemens and Halske, who have succeeded in making a common agreement with the tramway company, according to which a portion of the latter's lines will be worked on the trolley system. The European continent is very fruitful in electric-railway schemes which will probably, at no distant date, be practically put into execution.

The Design and Erection of Flour Mills on the Roller System.—XXI.

ROLLER MILLS.

WITH the introduction of the roller mill and the improved machinery necessary for a complete roller system, the manufacture of flour has, during the last 16 to 18 years, been entirely revolutionised, this great improvement being brought about by the milling engineer, and not, as it is popularly supposed, by the miller. Nor can it be said that the milling engineer has received any encouragement from the miller in improving flour-making machinery; but, on the contrary, the engineer has had not only to fight against prejudice, but also to teach the miller how to use and handle the complicated machinery required in a modern roller plant.

The British miller took it for granted that the millstone was as essential for the manufacture of flour as sowing the seed is for growing crops. The engineer regarded the stone system as having done good work in the past, but that the time had now arrived for a more scientific process. He also saw that if the British miller was to hold his own against foreign competition the millstone must give place to the roller mill.

Prior to the introduction of the roller system in this country the British miller was at least 80 years behind the Hungarian miller. Hungary has given to the world the science and art of flour manufacture, although the writer is quite alive to the fact that the Hungarian system is unsuitable for the English miller, and for the following reasons:—In Hungary an extensive subdivision of products is made with advantage, which is for the most part useless and unsuitable in this country. Secondly, in that country there are a great number of different qualities of flour, of which one-half would be too low for consumption in this country; and, lastly, the unnecessary purifying of middlings adopted by the Hungarians. So far as the art of separation is concerned, the English miller of to-day is years behind the Hungarian.

From what has been said as to the Hungarian system the reader will see that these people are masters of the art of flour manufacture. Then, again, the principal text-book of the science of milling was written by Professor Kick, of Zürich. There are a number of other foreign books, but Professor Kick's "Flour Manufacture" is recognised by all milling engineers as the highest authority on the subject. Thanks, however, to the efforts of the milling engineer, the English miller is now able to compete with all comers, with a result that American flour is becoming a drug in the hands of those who import it.

Roller Mills.—In design, roller mills are, strictly speaking, of only two kinds—viz., the horizontal type, with either two or four rollers in one frame, and the vertical three-high roller mill. In this latter design the three rollers are placed vertically over each other, and the centre roller is fixed so that the top and bottom rollers can be adjusted to their work. Grooved rollers for breaking down the wheat berry are called the break rollers; for reducing the semolina and middlings for the production of flour smooth rollers are used.

Both the vertical and the horizontal roller mill turn out very good work, and there is very little to choose between them. Thousands of both designs are now at work, and so far as constructional and working detail is considered, the roller mill is now practically a perfect machine. The rollers are the principal part of the machine, so we will now consider the manufacture of chilled iron rollers for flour mills; and

before commencing this subject it may be said that so far no milling engineer has ever read a paper or written an article on the manufacture of chilled iron rollers. There are firms of milling engineers who never yet made a chilled roller, for this is looked upon as a speciality in the iron-founder's department. Other firms, after expensive experiments, have given up casting their own rollers, and obtain them from those who have a reputation for successful production.

Rollers have been made of stone, but trials with granite rollers have shown that the granite rollers soon lose their smooth surface and become very rough, small particles crumbling away; also they soon become eccentric in contour. Porcelain rollers are limited to fine semolina, more especially from soft wheats. Chilled cast iron has shown the greatest resistance to wear, and this is the one reason of its general use

The manufacture of chilled castings, especially chilled rolls, appears to be a subject upon which very little is known and less written about. Firms who have a reputation for producing good chilled castings guard their experiences in a very thorough manner, and regarded in a proper light it is only natural that this should be the case, for the reputation for producing good chilled castings means to those behind the scenes years of costly experiments, where to achieve a certain result time and money have not been taken into consideration. Under ordinary circumstances it is very hard to tell how a chilled roller is going to turn out. There may be imperfections in the surface, or want of uniformity in hardness or depth of chill. All this is only discovered after the machine work has been done, and this represents a heavy loss to the manufacturer.

The cause of the hardening of cast iron, when run in a molten state into cool metallic moulds and thus cooled quickly by a rapid conductor of heat, is not known. Mallet was the first to point out this fact—"that in solids cooling from fusion, their crystals arrange and group themselves with their principal axes in lines perpendicular to the cooling surfaces of the solids, or in the lines of direction in which the wave of heat has passed onward from the mass in cooling." It is not known why this particular arrangement of crystals should take place, and nothing is known why, when the cooling is rapidly effected, it should be accompanied by an intense hardening of the metal. A correct explanation of these phenomena might or might not enable us to select with precision the iron best suited for the purpose. As we are without this explanation, our selection of iron must depend upon experimental observations.

From observations and experiments it is acknowledged that carbon enters very largely into the chilling properties of cast iron. It is also generally understood that carbon exists in iron in two distinct forms—viz., in a state of chemical combination, or mechanically diffused through the mass in the form of crystalline graphite, which separates from the metal in the process of cooling.

"When grey cast iron in mass* is allowed to cool *slowly* from a state of fusion, as in the case of fluid metal standing in a foundry ladle, a large amount of graphitic matter known as "kish" separates and rises to the surface as the metal cools, whilst if this same metal be run into moulds and cooled *quickly*, the greater portion of this carbon remains unseparated from the iron, a portion of it assuming the combined form, with the production of a harder or white metal."

Iron that contains much graphitic carbon, with a dark grey granular or crystalline fracture, is known as grey iron. On the other hand, when iron has a *large amount* of combined carbon the colour of the metal is more or less white, with a granular or crystalline fracture. This is called white iron. Both grey and white iron are often to be seen in the same pig, and where these exist at intervals, as shown by fracture, the iron is termed mottled iron. For most purposes, that mixture which will give what may be called grey mottled iron will be well suited for chilled castings.

(*To be continued.*)

MESSRS. R. AND J. DEMPSTER, Manchester, will shortly commence the erection of an extensive ammonia-recovery plant at the Ardeer Ironworks, Ayrshire, belonging to the Glengarnock Iron and Steel Company.

MESSRS. THOMAS HOLCROFT AND SONS, ironfounders, Bilston, are enlarging their works. Already close upon 1000 hands find employment at this establishment, and it is estimated that, when the alterations are completed, the number employed will be greatly in excess of that figure.

* "Steel and Iron," by W. H. Greenwood, pp. 49 and 69.

Mechanical and Engineering Drawing.—VII.

BY A PRACTICAL DRAUGHTSMAN.

Practical Geometry and Mechanical Drawing.—As it has been necessary, in explaining the difference between a mechanical and a freehand or perspective drawing, to make use of terms which presuppose a knowledge of geometry by the student which he may not possess, and as it is advisable to take nothing for granted in the exposition of our subject, it will be necessary at this stage to define the meaning of the geometrical terms that will be made use of as we proceed, and to show how, by a special combination of lines, those geometrical figures are constructed which form the surfaces of objects whose delineations are subsequently to be obtained by orthographic projection.

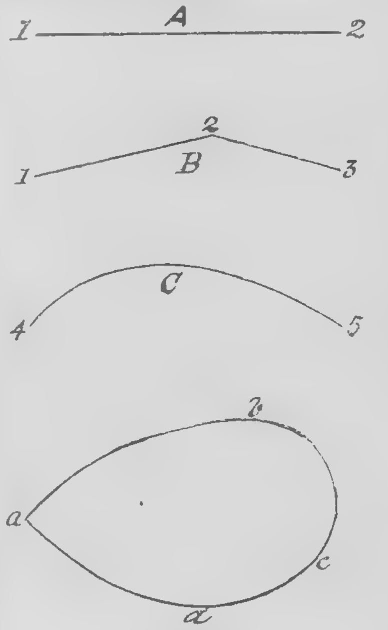


FIG. 14.

The term "geometry," in its generally-accepted sense, means the science or knowledge of *magnitude* reduced to system, and has to do with the measurement of lines, surfaces and solids. It has, like other sciences, two sides or branches, one "theoretical," which demonstrates or proves its principles, and the other "practical," or that which applies those principles to construction. Theoretical geometry, or Euclid, will seldom be referred to in the course of these articles, as most of the demonstrations used are self-evident; but practical geometry—a sub-division of which is the basis of our subject—must be understood by the student to such an extent as will enable him to work out the problems that will arise in the exposition of it.

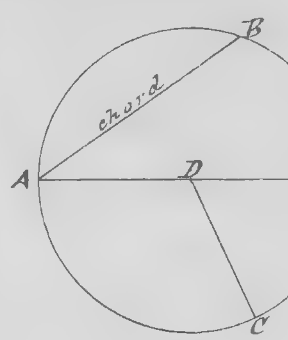


FIG. 15.

The two parts into which practical geometry is divided are: Plane geometry, which has reference only to the solution of questions relating to points, lines, and figures, situated in *one plane;* and solid geometry, which shows by special representations on *two or more* defined planes, the relations of the points, lines, and surfaces of bodies having length, breadth and thickness.

We would, in passing, guard the student, on his entering on the study of geometrical drawing, against wasting valuable time in working out the problems—many of which will be of no use to him—given in most text-books on the two subjects of plane and solid geometry, as all that is absolutely necessary for him to know in connection with either will be explained to him as occasion arises.

As we cannot form a conception of the *magnitude* of any material object without reference to one or more of its dimensions, and as each of these involves the idea of *extension* in some direction, the word *length* or its representative, "a line," would appear to be the first *term* used in geometry requiring definition, but as a *line* can have no existence till it is generated or drawn, our first term must be that of the *generator*, or "point." We therefore define:—

A *point*, as having no magnitude, that it is used to denote "position" only, and is represented geometrically by a dot or mark made by any pointed instrument, such as a pen, pencil, etc.

A *line*, as the path made by a point moving over a surface. It may be straight, crooked, or curved, according to the direction in which the point travels or moves.

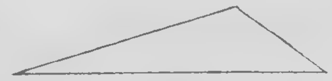


FIG. 16.

A *straight line*, as the shortest path that can be made by a point moving from one position to another, or the nearest distance between two points, as the line A between points 1 and 2.

A *crooked line*, as the path of a point that has changed its direction after moving in a straight line for a given distance—1 to 2,—as the line B from 1 to 3.

A *curved line*, as the path of a point that continually changes its direction, as the line C from 4 to 5.

If the path of a moving point changes in such a way as to enclose a certain amount of surface, then the enclosed surface is called a "figure," and the path its *boundary line*, as in Fig. 14, where the "point path" from *a*, through *b*, *c*, *d*, defines the form of the figure.

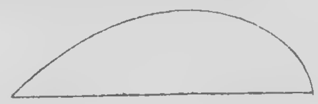
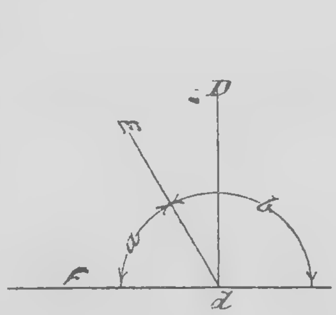


FIG. 17.

If a point move continuously in such a way as to be always at a given distance from some *fixed* point, then the space enclosed by the "point path" becomes the figure called a "circle," as the continuous line A B C (Fig. 15), any point in which is equidistant from D, which is called its *centre*.

It is evident from the foregoing that two *straight* lines cannot *enclose* a space, or *form* a figure, but that one such line in combination with a curved or a crooked line will effect this, as shown in Figs. 16 and 17, where we have in one case a straight line and a crooked one, and in the other a straight and a curved line, combined to form figures.

A *surface* is a magnitude that has extension in two directions only—viz., lengthwise and crosswise. Its dimensions—with one or two exceptions—are given as *length* and *breadth*.



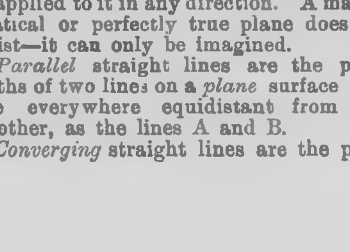


FIG. 18.

A *plane surface* is one that a perfectly straight edge will touch or coincide with if applied to it in any direction. A mathematical or perfectly true plane does not exist—it can only be imagined.

Parallel straight lines are the point paths of two lines on a *plane* surface that are everywhere equidistant from one another, as the lines A and B.

Converging straight lines are the point paths of two lines on a plane surface, which, if continued, meet and cross each other as the lines C D. When the paths or lines *increase* their distance from each other as they leave the meeting point, they are said to *diverge*.

An *angle* is formed when two straight lines meet each other in a point, as D meets F in *d* (Fig. 18). If the inclination of one line to the other be such that the angles are equal on both sides of the meeting point, then the angle formed by the lines D and F is a *right angle*. If they are not equal, as in the meeting of E and F in *d*, then the *smaller* of the two, or angle *a*, will be an *acute* angle, and the *larger*, or angle *b*, will be an *obtuse* angle. And as the line D makes equal angles on both sides of it with the line F, the two lines D and F are *perpendicular* to each other.

(*To be continued.*)

Wrought Iron.

THE fifth of the course of six lectures on "Wrought Iron" was delivered on the 2nd inst. in the Chemistry Lecture Theatre of the Mason College, Birmingham, by the lecturer on metallurgy, Mr. Thomas Turner. The speaker observed that in previous lectures the processes had been described by which puddled iron is obtained from cast iron, and although in times past great expectations had been raised in the direction of mechanical puddling furnaces, particularly of the Danks furnace twenty years ago, puddling is still almost universally conducted in the single furnace, such as has been so long in use. In all of the mechanical furnaces the wear and tear has cost more than the labour which is saved. The puddled iron thus obtained is by no means pure or homogeneous, but contains nearly four per cent. of intermingled slag even in the less quality of iron, and a variable amount of other impurities. It is therefore cut up and arranged in bundles or "piles," which are heated in a "mill" furnace, and rolled or hammered into finished iron, of which there are various qualities, such as "best," "best best," and so forth, depending on the selection of the materials and the care exercised in manufacture. During the reheating and subsequent treatment considerable waste takes place, and the care with which the details of this process are conducted often has the greatest possible influence in the success of an ironworks. If the iron of the piles is irregularly arranged, or if the weight is not quite correct for the size and quality of iron required, loss results from the production of spilly ends and ragged edges, which have to be cut off. If the iron is heated too long or in an oxidising atmosphere, it is oxidised, and too much slag is produced, while if it is not heated equally through it does not roll regularly. The waste is also affected by the size of the iron and by the nature of the bottom of the mill furnace, being greatest with a fluid oxide bottom, considerable with a sand bottom, and least with a bottom of basic slag. In the first case, however, the waste is partly compensated for by the production of a rich and valuable fettling called "best tap." Puddled iron rich in phosphorus also loses more during reheating than purer qualities, and all these circumstances have to be taken into account in arranging the weight of the pile. Mill furnaces are still very generally heated by direct firing, and require about 11cwt. of coal per ton of iron; but gas furnaces are becoming more and more general, and lead to reduced waste, owing to the more complete control exercised over the working of the furnace. The latest improvement in this direction which has met with general success is the new form of Siemens furnace, in which not only the waste heat, but also the waste gases are utilised. Several of these are now in operation in the Midlands, the fuel consumption being about one-third of that when direct firing is employed. The lecture was illustrated with a number of lantern slides, showing, from works chiefly in the Birmingham district, the details of the furnaces described, together with a collection of best iron from well-known makers.

ON the 4th inst. Messrs. Craig, Taylor and Co. launched from their yard at Thornaby-on-Tees a steel and iron tank steamer. Her dimensions are:—343ft. by 42ft. by 28ft. depth moulded to spar deck. The triple-expansion engines, by Mr. John Dickinson, Palmer's Hill Engine Works, Sunderland, have cylinders 25in., 40in., and 65in. in diameter by 45in. stroke. There are two large double-ended boilers of Siemens-Martin steel, fitted with corrugated furnaces, constructed for a working pressure of 150lb.

On Moduli of Sections.

[CONTRIBUTED.]

(*Continued from page* 72.)

If a section is of such a form that the neutral axis passes through the middle point, then the value of k in the Equation II. may be different for tension and compression, in which case the least value of k is to be taken.

The sum of all the products which can be formed by taking a unit of sectional area and multiplying it into the square of its perpendicular distance from a certain straight line, or a certain point, is called the moment of inertia of the section.

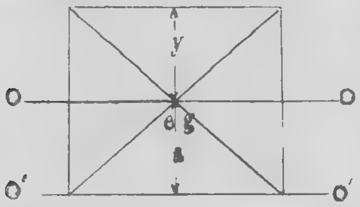


Fig. 3.

When the distance is measured from a straight line, then the moment is distinguished as the equatorial moment of inertia; when measured from a point it is called the polar moment of inertia.

Let us denote the moment of inertia of a section referred to an axis with the letter I; and, again, let this moment of inertia, referred to the parallel axis passing through the centre of gravity, be distinguished by the letter I_g. The connection of these two moments will be obvious from Fig. 3.

These two moments written in the form of equations will appear as follows:—

$$\begin{aligned} I_g &= \Sigma f y^2 \\ I &= \Sigma\ f\,(a+y)^2 \\ &= \Sigma\ f\,(a^2+2\,a\,y+y^2) \\ &= \Sigma\ (f\,a^2+2\,a\,f\,y+f\,y^2) \\ &= \Sigma\ f\,a + \Sigma 2\,a\,f\,y + \Sigma\ f y^2 \\ &= a^2\,\Sigma\ f + 2\,a\ \Sigma\ f\,y + \Sigma\ f\,y^2 \end{aligned}$$

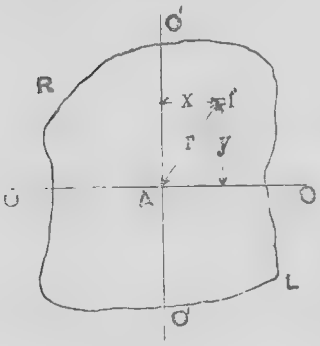


Fig. 4.

Now the sum of the f_s ($\Sigma\ f$) is equal to the area of the section, and $\Sigma\ f\ y = 0$; therefore, we can write the last equation thus: $I = a^2\ F + \Sigma\ f\,y^2$, in which F represents the total area of section.

By substituting I_s for its value in the equation, we obtain the two following equations:—

$$\left.\begin{aligned} I &= a^2\ F + I_s \\ I_g &= I - a^2\ F. \end{aligned}\right\} \quad \text{(III.)}$$

In Fig. 4, let R L be any plane and let f be any unit of area in the plane; it is required to find the relation of the equatorial moment and polar moments of this unit of area.

Let I_x and I_y be the moments of inertia of the unit f referred to the axes O O and $O^1\ O^1$ respectively, and let I_p be the polar moment referred to the point of intersection A of the above axes, which are at right angles to one another.

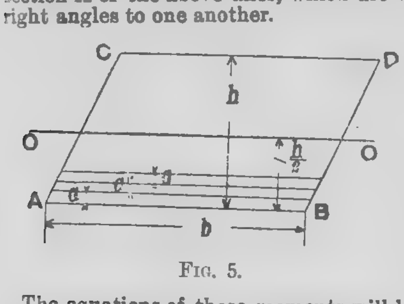


Fig. 5.

The equations of these moments will be as follow:—

$$\begin{aligned} I_x &= \Sigma\ f\,y^2 \\ I_y &= \Sigma\ f\,x^2 \\ I_p &= \Sigma\ f\,r^2 \\ &= \Sigma\ f\,(x^2+y^2) \\ &= \Sigma\ (f\,x^2 + f\,y^2) \\ &= \Sigma\ f\,x^2 + \Sigma\ f y^2 \end{aligned}$$

$\therefore\ I_p = I_y + I_x$, or $= I_x + I_y$ ......(IV.)

Having the Equations II., III., and IV. at our command, we will now proceed to calculate the moments of inertia of the most important sections. We will take first a bar having a parallelogram as form of section, and calculate the moments of inertia of this section.

Parallelogram. — Imagine a parallelogram A B C D divided into n strips parallel to the base A B, each of these strips having the height δ infinitely small. Let h = height of the parallelogram, then $h = n\ \delta$. Now $I = \Sigma\ f\ (a + y)^2$, and $(a + y) = h = n\ \delta$.

$$\begin{aligned} \therefore I &= f\,\delta^2 + f(2\,\delta)^2 + f(3\,\delta)^2 + \text{——} + f(nd)^2 \\ &= f\ \delta^2\ (1^2 + 2^2 + 3^2 + \text{——} + n^2) \end{aligned}$$

But the last factor $= \dfrac{n^3}{3}$, if $n = \infty$; and since $f = b\ \delta$, hence

$$\begin{aligned} I &= b\,\delta\ \delta^2\,\frac{n^3}{3} = \frac{b}{3}(n\,\delta)^3 \\ &= \frac{b\ h^3}{3} \end{aligned}$$

Let I_g denote the moment of inertia of the parallelogram referred to the centre of gravity axis O O; then according to Equation III.:—

$$\begin{aligned} I_g &= I - a^2\ F \\ &= \frac{b\,h^3}{3} - \left(\frac{h^2}{2}\right)\ b\,h = \frac{b\,h^3}{3} - \frac{b\,h^3}{4} \end{aligned}$$

$$\therefore\ I_g = \frac{b\ h^3}{12}$$

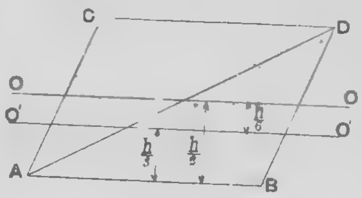


Fig. 6.

As already mentioned, the modulus of the section

$$W = \frac{I_g}{e};\ \text{and } e \text{ in this case} = \frac{h}{2}$$

$$\begin{aligned} \therefore\ W &= \frac{b\ h^3}{12} \times \frac{2}{h} \\ &= \frac{b\ h^2}{6} \end{aligned}$$

2. *The Triangle* (Fig. 6).—Draw the diagonal of the parallelogram A B C D, in this case say A D; then the parallelogram is divided into two equal triangles A B D and A C D. The moments of inerta of the two triangles, referred to the centre of gravity axis OO, are evidently equal, and the sum of their moments must be equal to the moment of parallelogram. Hence the moment of inertia (I) of the triangle A B D is equal to half that of the parallelogram—that is:

$$I = \tfrac{1}{2}\,\frac{b\ h^3}{12} = \frac{b\ h^3}{24}$$

Now let I_g be the moment of inerta of the triangle A B D referred to the axis O'O' passing through the centre of gravity of the triangle A B D.

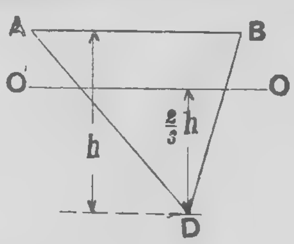


Fig. 7.

Then:—

$$\begin{aligned} I_g &= I - a^2\ F \\ &= \frac{b\ h^3}{24} - \left(\frac{h}{6}\right)^2 \frac{b\,h}{2} \\ &= \frac{b\ h^3}{24} - \frac{b\ h^3}{72} \\ &= \frac{b\ h^3}{36} \end{aligned}$$

The corresponding value of the modulus will be:—

$$\begin{aligned} W_1 &= \frac{b\,h^3}{36} \div \frac{2}{3}\,h \\ &= \frac{b\ h^3}{36} \times \frac{3}{2\,h} \\ &= \frac{b\ h^2}{24} \end{aligned}$$

The above value of the modulus is for the upper part of the triangle A B D, but the triangle is thus divided into two unlike portions, therefore another value of the modulus must be found. Then the value of the modulus will be different—viz.:

$$\begin{aligned} W_2 &= \frac{b\ h^3}{36} \div \frac{h}{3} \\ &= \frac{b\ h^3}{36} \times \frac{3}{h} \\ &= \frac{b\ h^2}{12} \end{aligned}$$

From that which has preceded, a new value of I for the triangle in Fig. 7 can be found:

$$\begin{aligned} I &= I_g + a^2\,f \\ &= \frac{b\ h^3}{36} + \left(\frac{2}{3}h\right)^2 \frac{b\ h}{2} \\ &= \frac{b\ h^3}{36} + \frac{4}{9}\,\frac{b\ h^3}{2} = \frac{b\ h^3 + 8\ b\ h^3}{36} \\ &= \frac{b\ h^3}{4} \end{aligned}$$

The polar moment inertia of point is given by the equation $I_p = I_x + I_y$; supposing one dimension of the plane to be very small (say, x), then I_y would be very small, and consequently $I_p = I_x$.

Let the base A B of the triangle A B D in Fig. 7 become infinitely small, then the moment (equatorial) of inertia of the triangle would also be its polar moment of inertia—that is, the polar moment of inertia of the triangle A B D referred to the vertex D is:—

$$I_p = \frac{b\ h^3}{4}$$

(*To be continued.*)

The Design and Construction of Stationary Engines.—XLVIII.

In the case of ordinary horizontal engines for manufactories and mills having overhung cranks, as in Fig. 188, the crank-shaft is subjected to a combined bending and twisting action.

The moment of this combined bending and twisting action may be expressed as a simple equivalent bending (M') or twisting moment (T'), which is for $M' = \tfrac{1}{2}(BM + \sqrt{BM^2 + TM^2})$ approximately; or, more simply, $M' = 0{\cdot}9BM + 0{\cdot}4TM$; where BM = bending moment = P × b (see Fig. 206), b = distance from centre of shaft bearing to centre of crankpin, and T = the twisting moment = P × L.

The equivalent twisting moment is $TM = M + \sqrt{M^2 + T^2}$.

The resistance of a shaft to a transverse or bending stress, as shown by Table XXIX., is only half that for the twisting stress.

The formula for bending as given in Table XXIX. is $BM = \dfrac{\pi}{32} f d^3 = \dfrac{d^3 f}{10{\cdot}2}$. From which we have $d = \sqrt[3]{\dfrac{BM}{f} \times 10{\cdot}2}$; or, $d = \sqrt[3]{\dfrac{BM}{784}}$ for iron, and $d = \sqrt[3]{\dfrac{BM}{980}}$ for steel.

Taking the approximate formula for bending moment $M' = 0{\cdot}9BM + 0{\cdot}4TM$, then we have $\dfrac{d^3}{10{\cdot}2}\ f = 0{\cdot}9\,B\,M + 0{\cdot}4\,T\,M = Pb \times (0{\cdot}9 + 0{\cdot}4)$, or $d = \sqrt[3]{\dfrac{Pb \times 1{\cdot}3}{f} \times 10{\cdot}3}$.

In such calculations, however, it is convenient as a check to employ the graphic method, proposed by the late Professor Rankine, for obtaining the value of the combined twisting and bending stress, which is as follows:—In Fig. 206, E B is the centre line of the crankshaft, and C A is the radius of crank. Join B A, and bisect the angle A B C by the line B F. From A draw the line A D perpendicular to B F, which it intersects at D. From D the line D E is drawn perpendicular to E B, the centre line of the shaft.* Then if the shaft diameter be calculated by the formula previously given for a bending moment P × B E (P = total load on crankpin in lb.), it will be of sufficient strength to withstand the combined bending and twisting action of the load applied at A.

The length B E may be calculated thus:

—$AB = \sqrt{AC^2 + CB^2}$.

Then $BE = \dfrac{HB + CB}{2}$ (since HB = AB).

To illustrate the application of the method, let us take as an example a horizontal engine having steam cylinder 20in. diameter by 48in. stroke, boiler pressure 85lb. Then neglecting the increase of pressure on the pin due to angularity of connecting rod, we have P = 314 × 85 = 26,690lb. TM = 314 × 85 × 24 = 640,560in.-lb.

Then $d = \sqrt[3]{\dfrac{640{,}560}{1960}}$ = 7in. diameter (for steel) for twisting only.

Applying the graphic method, as above, it will be found that the distance BE = 24½in. The equivalent bending moment then becomes 26,690 × 24·5 = 653,905in.-lb. Then for bending, $d = \sqrt[3]{\dfrac{653{,}905}{980}}$ = 8¾in. dia. (for steel).

To facilitate such calculations, Table XXX. has been calculated from the torsional and bending moment of resistance of shafts

$TM = \dfrac{\pi}{16} f d^3 = 0{\cdot}196 \times f \times d^3$; TM = torsional moment of resistance, f = stress per square inch allowed—8000 for iron, 10,000 for steel. $BM = \dfrac{\pi}{32} f d^3$; $= 0{\cdot}098 \times f \times d^3$; B M = bending moment of resistance.

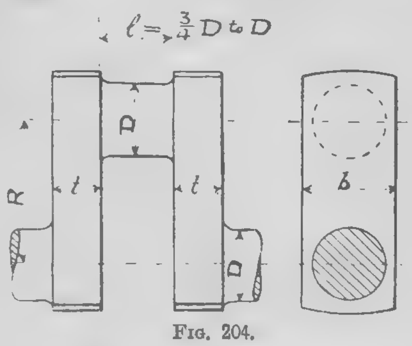


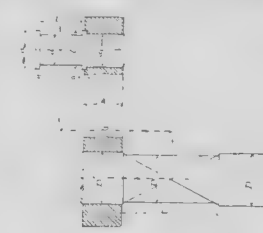
Fig. 204.

The second column gives the cube of the shaft diameter from 1in. up to 20in. in diameter.

Taking the last example, the equivalent bending moment = 653,905in.-lb. In bending moment column in table (steel 10,000) it will be seen that the required diameter lies between 8½ and 9in., agreeing with the calculation given above.

In the case of large mill engines, it is necessary to consider other points besides the bending and twisting moments. Where heavy rope and belt fly-wheels are employed, this is imperative.

The consideration which should here weigh most in determining the proper diameter and length of crankshaft neck is the pressure per square inch put thereon by the weight of the fly-wheel and shaft, if hot bearings are to be avoided.



205.

The limiting pressure on main bearings will in first-class engines rarely be found over 200lb. per square inch of projected area of bearing. About 140lb. per square inch is a fair average load with good lubrication. To illustrate this point, we will here give three examples from actual practice, where the results have been found satisfactory.

(1.) A pair of compound tandem engines, indicating 1000H.P., fly-wheel 65 tons weight, including shaft about 69 tons. Crank-necks 16in. diameter × 36in. long, shaft 18in. diameter at middle, centre of necks 10ft.

(2.) Pair of side-by-side compound engines, indicating 1300H.P., fly-wheel 78 tons weight, (with shaft) about 86 tons. Crank-necks 17in. diameter × 40in. long, shaft 24in. diameter at middle, centres of bearings apart 11ft. 6in.

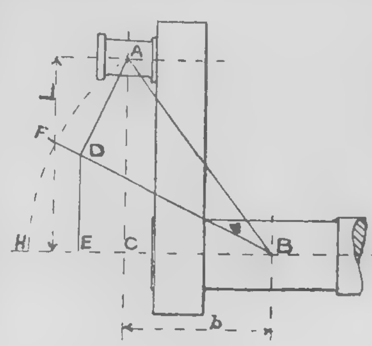


Fig. 206.

(3.) Pair of side-by-side compound engines, fly-wheel 72 tons weight, (with shaft) about 80 tons. Necks 19in. diameter × 38in. long, shaft 24in. diameter at middle, centres of bearings apart 11ft. 9in.

The pressure per square inch on projected area of bearing is in each case as follows:—

$$(1.) = \frac{69 \times 2240}{2 \times 16 \times 36} = 134\text{lb.}$$

* A simple method for finding the point E has been proposed by Mr. C. N. Pickworth, Wh. Sc. Referring to Fig. 206, with B as centre and BA as radius, describe the arc A H, bisect H C, and the point E will be found.

$$(2.) = \frac{86 \times 2240}{2 \times 17 \times 40} = 141\text{lb.}$$

$$(3.) = \frac{80 \times 2240}{2 \times 19 \times 38} = 124\text{lb.}$$

The heating of main bearings when engines are first started is not uncommon, and is very often caused by dust or grit getting into the bearings. It may also be due to want of proper alignment of the shaft; more often, however, it is caused by the flexibility of the shaft. Provision should be made to accommodate the bending of the shaft by the weight of the heavy fly-wheel, for although, where a heavy rope pulley is employed, the necks may be ample for the bending and twisting stresses already referred to, yet they will *bend* somewhat under the great weight of such wheels.

This bending is a very important matter, and ought to be carefully considered in first-class work. It is best provided for by inclining the bearings inwards slightly, either by boring the brasses the required amount out of level, or packing the pedestal (if loose) up on the outer edge.

TABLE XXX.

Dia. of Shaft.	Cube of Shaft Diameter.	Twisting Moment. Iron, 8000 *f.*	Twisting Moment. Steel, 10,000 *f.*	Bending Moment. Iron, 8000 *f.*	Bending Moment. Steel, 10,000 *f.*
1	1·00	1,570	1,962	785	981
1¼	1·95	3,066	3,832	1,533	1,916
1½	3·37	5,299	6,624	2,649	3,312
1¾	5·35	8,414	10,517	4,207	5,258
2	8·00	12,560	15,700	6,280	7,850
2¼	11·39	17,883	22,354	8,941	11,177
2½	15·62	24,531	30,664	12,265	15,332
2¾	20·79	32,651	40,814	16,325	20,407
3	27·00	42,390	52,988	21,195	26,494
3¼	34·32	53,895	67,369	26,947	33,684
3½	42·87	67,314	84,143	33,657	42,071
3¾	52·73	82,793	103,491	41,396	51,745
4	64·00	100,480	125,600	50,240	62,800
4¼	76·76	120,523	150,652	60,261	75,326
4½	91·12	143,066	178,833	71,533	89,416
4¾	107·17	168,260	210,325	84,130	105,162
5	125·00	196,250	245,313	98,125	122,656
5¼	144·70	227,184	283,980	113,592	141,990
5½	166·37	261,209	326,511	130,604	163,255
5¾	190·10	298,472	373,090	149,236	186,545
6	216·00	339,120	423,900	169,560	211,950
6¼	244·14	383,200	479,125	191,600	239,562
6½	274·62	431,160	538,951	265,530	269,475
6¾	307·54	482,848	607,560	241,424	302,780
7	343·00	538,810	673,138	269,405	336,569
7¼	381·07	598,293	747,866	299,146	373,933
7½	421·87	662,344	827,930	331,172	413,965
7¾	465·48	730,810	913,512	365,405	456,756
8	512·00	803,840	1,004,800	401,920	502,400
8½	614·12	964,176	1,205,220	482,088	602,610
9	729·00	1,144,530	1,130,662	572,265	715,332
9½	857·37	1,346,079	1,682,599	673,039	841,299
10	1000·0	1,570,000	1,962,500	785,000	981,250
10½	1157·6	1,817,471	2,271,839	908,735	1,135,919
11	1331·0	2,089,670	2,612,088	1,044,835	1,306,044
11½	1520·8	2,387,774	2,989,717	1,193,887	1,494,858
12	1728·0	2,712,960	3,391,200	1,356,480	1,695,600
12½	1953·1	3,062,400	3,828,000	1,531,200	1,914,000
13	2197·0	3,449,290	4,311,612	1,724,645	2,155,806
13½	2460·3	3,857,600	4,822,188	1,928,800	2,411,094
14	2744·0	4,308,080	5,385,100	2,154,040	2,692,550
14½	3048·6	4,940,000	6,175,256	2,470,000	3,087,628
15	3375·0	5,298,750	6,623,428	2,649,375	3,311,714
15½	3723·87	5,839,028	7,298,785	2,919,514	3,649,392
16	4096·0	6,430,720	8,038,400	3,265,360	4,019,200
16½	4492·12	7,043,644	8,804,595	3,521,822	4,402,297
17	4913·0	7,703,584	9,629,480	3,851,792	4,814,740
17½	5359·37	8,403,492	10,504,365	4,201,746	5,252,182
18	5832·0	9,144,576	11,430,720	4,572,288	5,715,360
18½	6331·62	9,927,980	12,409,965	4,963,990	6,204,982
19	6859·0	10,754,912	13,443,550	5,377,456	6,721,775
19½	7414·87	11,626,516	14,533,145	5,813,258	7,266,572
20	8000·0	12,544,000	15,680,000	6,272,000	7,840,000

The amount of this inclination or slope which should be given to the brasses has to be calculated for the load in any given case.

The slope at the ends of a shaft of uniform diameter, supported at the ends and loaded in the middle, can be found by Rankine's formula as follows :—

$$s = \frac{W L^2}{16 E I} = \frac{4 W C^2}{0{\cdot}7854 E D^4} \quad \ldots\ldots\ldots(1),$$

where s = slope in inches, L = span in inches, W = weight on shaft in lb., E = modulus of elasticity = 27,000,000 for iron, and 30,000,000 for mild steel, I = moment of inertia of section = $0{\cdot}0491 d^4$, C = half span of shaft in inches. The deflection at the centre is found by the formula :—

$D = \dfrac{W L^3}{48 E I}$ (2), where D = deflection in in.

Taking example (1): assuming the weight of the wheel only 65 tons, find slope from formula (1) :—

$$s = \frac{W L^2}{16 E I}$$

$$= \frac{145{,}600 \times 14{,}400}{16 \times 30{,}000{,}000 \times 3217{\cdot}7} = \frac{1}{800} \text{ nearly.}$$

The cant for a 36in. bearing will therefore be $\frac{\frac{1}{800}}{36} = \frac{1}{22}$ of an inch; but as the shaft is increased in the middle to 18in. diameter, the slope will be about $\frac{1}{1770}$th, and the cant required about $\frac{1}{50}$ of an inch. The actual slope will be somewhat less than this, as the boss of the wheel, being about 3ft. deep, helps greatly to stiffen the shaft, and the centres of pressures on the shaft will be somewhere about a foot on either side of the wheel centre, thus practically reducing the length of the span by that amount.

In practice, however, it is better to allow for a somewhat greater slope than the formula gives, since the slope of the shaft at the ends varies as the square of the length. If the pedestals be canted sufficient to throw the shaft on to the outside edges of the bearing, it will be equivalent to lengthening the span by the amount of the two half-lengths of the bearings, and as the slope varies as the square of the length, the slope is increased by 50 per cent., consequently the cant allowed may be 50 per cent. greater than that given by the formula, and this will ensure the necks bearing the full lengths of the brasses. It is obvious that in designing engines working on to two cranks with fly-wheel between, it is desirable to bring the bearings as close up to the wheel as possible. In some cases, where the rope wheels are of great width, the main bearings are placed as close up to the boss of wheel as foundations will permit, additional bearings of less than the ordinary width being placed close to the cranks, and the eccentrics and other gear being fixed on the shaft between them.

Fig. 205 shows the crankpin, crank, and necks for several sizes of engine, the dimensions for which are given in Table XXXI., and are suitable for steam pressures up to 100lb.

TABLE XXXI.—DIMENSIONS OF CRANKNECKS AND CRANK PINS.

Size of Engine. Dia. Stroke.	A (= 0·82D)	B	D	D' (= 1·1D)	D (= 1·2D)	L	d	d' (= 1·1d + ¼)	d² (= 1·2d + ¼)	l (= 1·5d)	a (= 0·11d + ¼)	E F
in. in.												
12 × 24	4½	11⅜	5½	6⅛	6½	10	2¾	3¼	3½	4	½	14
14 × 28	4¾	13½	6	6¾	7¼	12	3¼	3¾	4	4¼	9/16	16½
16 × 36	5¼	15¼	7	7¾	8¼	14	3½	4	4½	5	⅝	18½
18 × 42	6	16½	7¾	8¼	9¼	14	4¼	4¾	5	6	11/16	20½
20 × 48	6½	18¾	8¼	9¼	10	16	4½	5¼	5¾	6½	¾	24¼
22 × 48	7	19¾	8¾	9¾	10½	16	5	5½	6¼	7¼	13/16	25¼
24 × 48	7¼	20¾	9¼	10¼	11¼	18	5¼	6¼	6¾	8	13/16	27
26 × 48	8	23¼	10¼	12¼	13	20	6	6¾	7¼	9	⅞	28
28 × 54	9½	25¼	11½	13	14	22	6½	7¼	8	9½	15/16	31½
30 × 54	10¼	28½	13	14½	15½	26	7	7¾	8¾	10	1	34½
32 × 54	10¾	29⅝	13½	15	16¼	26	7½	8	9¼	10½	1 1/16	34¾

For small portable and inverted cylinder engines, the most convenient form of shaft to use is the crankshaft as shown in Fig. 204. These are usually made of forged scrap iron or mild steel, and a number of firms lay themselves out specially to supply them to the trade.

The diameter of such shafts may be found approximately by the following formulæ :—

For small engines with single cranks :—

$$D = \sqrt[3]{\frac{T}{10{,}000}} \times 5{\cdot}1 \times 1{\cdot}3 \text{ for steel.}$$

For small engines with double cranks :—

$$D = \sqrt[3]{\frac{T \times \frac{3}{2}}{10{,}000}} \times 5{\cdot}1 \times 1{\cdot}18 \text{ for steel,}$$

where D = dia. of shaft in inches (in neck). C = constant = 10,000 for mild steel. C = constant = 8000 for wrought iron. T = twisting moment in in.-lb. = A × P × R. A = area of one cylinder. P = boiler presure. R = radius of crank in inches.

The thickness t of the crank arm × the breadth b squared should = the diameter of the shaft cubed, or $t \times b^2 = D^3$.

Example.—Find size of crankshaft for a pair of inverted cylinder engines having cylinders 8½in. dia. × 12in. stroke, boiler pressure 80lb., and double cranks.

$$D = \sqrt[3]{\frac{T}{10{,}000}} \times \tfrac{3}{2} \times 5{\cdot}1 \times 1{\cdot}18.$$

This will be near enough for practical purposes if written :—

$$D = \sqrt[3]{\frac{T}{10{,}000}} \times 9.$$

$$T = 27{,}216\text{lb.}$$

$$D = \sqrt[3]{\frac{27{,}216 \times \frac{3}{2}}{10{,}000}} \times 5{\cdot}1 \times 1{\cdot}18 =$$

$\sqrt[3]{24{\cdot}9}$ nearly, = 2·9in., or, say, 3in. diameter.

The thickness t may usually be ⅔rds of D, and the breadth b = 1·2 D. The length l of crankpin = ¾ths D to = D.

(To be continued.)

An American has devised a method of signalling by incandescent lights, by which the whole letter is shown at once instead of instalments, as is usual with the Morse code. The apparatus consists of a narrow box, open on one side, containing a row of 106 incandescent lamps. Two of these lamps represent a dot and 10 a dash. The signals, it is said, have been successfully read at a distance of 10 miles at night and four miles in the daytime.

Railway Work in Modern Warfare.

At a recent meeting of the Goldsmiths' Institute Engineering Society, Captain Huleatt, R.E., gave a most interesting paper on "Railway Work in Modern Warfare." Captain Huleatt's remarks on the subject were the more interesting, as many were the result of his personal experience during the Egyptian expeditions of 1882 and 1884-85. Captain Huleatt commenced by saying that the general uses of railways in war may be summed up under four heads: (1.) To concentrate troops at the points where they are required at the beginning of a campaign. (2.) To transfer an army from one part of the theatre of war to another, or to bring up troops as reinforcements during a battle. (3.) To bring up stores and supplies for the army during a campaign, such as food, clothing, ammunition, etc. (4.) To take back sick and wounded and prisoners from the front to places where they can be taken care of.

A general commanding an army will therefore do all he can: (1) To destroy those lines which are useful to his enemy and of no use to himself. (2.) To utilise his own lines of rail, repairing any damage which the other side may do them. (3.) It will often be worth while to make a line of railway specially for use in a campaign, as was done by the Russians in 1877 and by ourselves in Egypt in 1884-85. Some of the uses to which railways have been made use of in war may be instanced, such as by the Germans in 1870-71, when the troops to be taken to the frontier amounted to 456,000 men, 135,000 horses, and 14,000 guns and carriages. These were carried to the frontier in 1205 trains, and some of the corps had to travel 380 and 440 miles. The whole movement took about 15 days. It must not be forgotten that bringing an army to the front is a very different thing to bringing a body of civilians. Soldiers must take their arms, horses, guns, wagons, etc., in the same trains with themselves. The German army before Paris required 1800 tons per day of stores and reinforcements to the extent of 2000 per day, and about the same number of sick and prisoners to be sent to the rear—no small work.

In the Atalanta Campaign in 1864-65, Colonel M'Callum, who had the management of the railways, divided the staff into two departments—transportation and construction. In the former department 12,000 men were employed and in the latter 5000. As an example of what the construction corps were capable of doing, the lecturer mentioned the Chattahoochee Bridge, north of Atalanta. This trestle-work bridge, 780ft. long and 92ft. high, was built in four and a half days, a feat of which any engineer might be proud. During this war no less than 26 miles of bridges were built or rebuilt and 642 miles of track laid, the amount of track destroyed by both sides equalling 750 miles.

Having described the uses that railways in war are put to, the lecturer went on to refer to the work of demolition. This may be divided into two classes—those in which it is intended to completely destroy and those in which it is desired to render the line only temporarily useless.

The simplest, though not the quickest way of interrupting the line, is to take up the permanent way and carry off the materials. The enemy is thus sure to be considerably delayed. Roughly speaking, if the material is on the ground, it takes about nine times as long to relay as it did to take it up.

The next important question is how to restore a line that has been destroyed, and is an operation in which there is unlimited scope for an engineer to display his practical skill and resource. For instance, suspension bridges can be made good with telegraph wires. Embankments which have been cut must be filled in or bridged over, tunnels if blocked must be cleared, or if the hill is not a very high one the tunnel can be converted into an open cutting or a new line taken round the hill.

Then we have sometimes to deal with break of gauge. The Russian railways are most of them 5ft. gauge, and the German 4ft. 8½in.; and the question arises, if one country is invading the other, Is it better to alter the gauge or transfer loads from one set of wagons to another? Our Indian 5ft. 6in. gauge and Russian 5ft. are gradually getting nearer, and if they ever meet we shall have the same problem to deal with. In 1877 the Russians got over a difficulty of this kind by placing two sets of rails on the same sleepers for a distance of 13½ miles. One pair of rails were 4ft. 8½in. apart and the other 5ft. apart.

Captain Huleatt concluded his paper with complete schemes for new military railways, in which he strongly advocated the use of the 4ft. 8½in. gauge, and brought forward many very strong arguments in support of his opinion.

Mr. W. J. Spratling, B.Sc., F.G.S., at the conclusion proposed a vote of thanks to the lecturer, and warmly congratulated him on the concise manner in which he had put so many interesting facts together.—This was seconded by Mr. Lineham, M.I.M.E., who occupied the chair.

The Scotch Shipbuilding Trade.

During last month Scotch shipbuilders launched 16 vessels, of 15,922 tons, of which 4, of 13,400 tons, were steamers; 1, of 1500 tons, a sailing vessel; and 11, of 1022 tons, barges. The total was wholly contributed by the Clyde, and almost all by the upper reach. The most important vessel launched during the month—and, as a matter of fact, the only steamer above 500 tons—was the "Lucania," the second of the leviathans built by the Fairfield Company for the Cunard fleet. Her sister ship the "Campania" is, now that the joiners are in, rapidly approaching completion, and will in a week or two be ready for her trials. To the total, yards above Govan contributed 127 tons, Govan 13,130, Paisley and Renfrew 865, Port-Glasgow 1500, and Irvine 300. Of the tonnage, 855 tons were for foreign owners, and the balance for British.

Shipbuilding Notes.

Messrs. Thompson, Dickie and Co., Glasgow, have placed an order with Messrs. A. M'Millan and Son Limited, Dumbarton, to build a steel sailing ship of about 3000 tons deadweight.

The Fairfield Shipbuilding and Engineering Company Limited launched on the 1st inst. a steel screw steamer, 250ft. long by 32ft. broad and 16ft. 5in. deep, for the Royal Mail service conducted between Scotland and Belfast by Messrs. Burns.

The Dundee Loch Line Steam Shipping Company have contracted with Messrs. Palmer and Co., of Jarrow, to build a steamer with a carrying capacity of 7500 tons deadweight and horse-power of 2000 indicated. She will be 410ft. long, 49ft. broad, and 32ft. 6in. deep.

On the 1st inst., Messrs. Wm. Gray and Co. Limited launched a large screw steel steamer which has been built to the order of Messrs. J. Christensen and Co., of Bergen, Norway. The dimensions are:—Length over all, 327ft.; breadth, 41ft.; depth, 24ft. Her triple-expansion engines are being supplied by the builders. They will develop over 1100H.P. The cylinders are 23in., 36½in., and 62in. in diameter, with a stroke of 39in.

A satisfactory trial of the steamship "Burton," belonging to Messrs. Henry Samman and Co., of Hull, took place on the 28th ult. Her dimensions are:—Length over all, 285ft.; breadth, extreme, 36ft. 9in.; moulded depth, 19ft. She is fitted with engines by Messrs. Blair and Co. Limited, of Stockton-on-Tees, having cylinders 20½in., 33½in., and 55in. diameter, by 36in. stroke. A speed of 10½ knots was attained.

The new first-class gunboat "Circe," built at Sheerness Dockyard under the Naval Defence Act, underwent a most successful natural draught trial at the mouth of the Thames on the 27th ult. The trial was of eight hours' duration, during which the "Circe" covered 146 knots, giving her an average of 18¼ knots, or half-a-knot in excess of the speed anticipated by her designers. The indicated horse-power averaged 2618·8, the contract with Messrs. John Penn and Sons (Limited) being for 2500H.P.

The new battleship, "Repulse," made her contractors' eight hours' trial under natural draught on the 28th ult. The mean results of the eight hours' steaming were as follow:—Steam in boilers, 152·5lb.; vacuum, 28½in. in both condensers; revolutions, 99·4 and 99·3 per minute; indicated horse-power, 4967 starboard and 4566 port, thereby giving a collective indicated horse-power of 9533 horses, or 533 beyond the stipulated power. The mean air pressure in the stokeholds amounted to 0·45in., and the mean speed of the ship, as measured by the Cherub log, was 17·78 knots. The trial was in every respect a success.

Society of Engineers.

At a meeting of the Society of Engineers, held at the Town Hall, Westminster, on Monday evening, March 6, 1893, Mr. William Andrew McIntosh Valon, J.P., president, in the chair, a paper on "The Leicester Main Drainage, etc., and the Construction and Testing of the Sewage Pumping Engines and Boilers," was read by Mr. E. G. Mawbey, borough engineer.

The author, having referred to the great prosperity which Leicester had enjoyed for many years past, and the rapid increase of the population, said that in the year 1891 an Act of Parliament was obtained for the extension of the borough boundaries, for which scheme he was the engineer. The population was now 180,000, and the area 8534½ acres, the ratable value being about £650,000. Both the gas and water undertakings belong to the Corporation, and Mr. Alfred Colson, M. Inst. C.E., is engineer and manager of the gas department; and Mr. Frederick Griffith, M. Inst. C.E., engineer and manager of the water department.

The Corporation has recently finished floods prevention works which have cost £352,000. The drainage area (above Leicester) of the river which had been improved is 147 square miles. The new flood channel will carry off 400,000 cub. ft. of water per minute; or 1⅝in. of rainfall in 24 hours. The length of the principal weir constructed was 500ft. These works were for the most part designed and carried out by the late Mr. Joseph Gordon, M. Inst. C.E., and Mr. F. Griffith, M. Inst. C.E., but were completed and the new West Bridge designed by the author.

The flooding of the town, which in times past had been disastrous, was now entirely prevented within the boundaries of the old borough. The lecturer stated that storm outfall works designed by himself were now being carried out, and that the contracts let amount to £71,447. The main culvert is 8ft. in diameter and about 3¾ miles long, and would carry off about 70 million gallons of water in 24 hours from the built-upon area of the extended borough.

The author said that about 10 miles of new main intercepting brick sewers and storm outlets were being constructed in the borough, which were designed by the late Mr. Gordon, and would, when completed, have cost about £105,000. The sizes of the two main trunk sewers are 7ft. 3in. by 6ft. 3in. and 5ft. 3in. by 3ft. 6in. respectively. Nearly one-third of these works were executed under Mr. Gordon's personal direction, and the carrying out of the remainder, together with the preparation of the working drawings for rather more than half of these works, have devolved upon the author as the chief engineer. A further loan of £13,400 has recently been sanctioned for additional sewerage works in the added areas according to the plans of the author. The sewage is treated on the system of broad irrigation. The total area of the farm is 1700 acres, about 1400 of which will be available for sewaging, and are now being laid out and managed under the author's advice and direction. The total expenditure at present (exclusive of land) sanctioned was £58,900.

Mr. Mawbey gave a detailed description of the four independent rotative compound condensing beam engines, and the eight double-flued Lancashire steel boilers, each 30ft. by 7ft., working at 80lb. pressure per square inch, for pumping sewage from the Leicester sewers to the Beaumont Leys Sewage Farm through two 33in. cast-iron rising mains for a distance of about 1½ miles, and to a net height of 163·66ft., which, together with the engine and boiler-houses, workshops, and manager's house, cost £54,970.

The following are some of the dimensions given:—

	ft.	in.
Diameter of high-pressure cylinder..	0	30
Stroke	5	9¼
Diameter of low-pressure cylinder ..	0	48
Stroke	8	6

The author stated that to each engine there are two main sewage pumps of the piston and plunger type, one at each end of the beam with a stroke of 5ft. 9¼in., the diameter of the piston being 27¼in. The suctions of these pumps are single acting, and the deliveries double acting, with flap valves and very large waterways. The cast-iron fly-wheels weigh 21 tons each, and the beams 15 tons each, formed of double steel flitches 2in. thick, and 6ft. deep at the centre. There were two steel air vessels, each 25ft. 9in. high by 5ft. in diameter. The author then gave full particulars of the methods adopted in the official trials of these engines and boilers, which were drawn up and conducted by himself, and he also gave, in much detail, the results of these trials, compared with the requirements of the specification, the averages of these results in a few of the principal items being as follow:—

	lb.
Consumption of coal per actual H.P. per hour in water lifted..	1·915
Ditto per I.H.P. per hour	1·712
I.H.P. per engine working at 12·051 revolutions per minute.	199·63
Actual H.P. per engine in water lifted working at 12·051 revolutions per minute	178·47
Ditto in percentage of I.H.P....	89·41
Duty in weight of water lifted per 112lb. of coal	115,913,333

Nixon's navigation Welsh coal was used.

Mr. Mawbey explained that as these engines can be worked safely at about 15 revolutions per minute, each of them is capable of developing well over 220 actual horse-power in water lifted. He stated that the engines and boilers were designed by the late Mr. Joseph Gordon, M.I.C.E., assisted by Mr. T. E. Laing, Assoc. M.I.C.E., and Messrs. Gimson and Co., of Leicester, were the makers, the manufacture and erection being done under the author's personal supervision as successor to Mr. Gordon when that gentleman was appointed chief engineer to the London County Council; and that Mr. Stockdale Harrison, F.R.I.B.A., of Leicester, designed the buildings. The total cost of carrying out the schemes he had mentioned would be nearly two-thirds of a million sterling.

Notices of New Books.

The Standard Electrical Dictionary. By T. O'Conor Sloane. London: Crosby Lockwood and Son.

The rapid development of electrical science, and the multifarious applications of electrical energy which have been made during the last few years, render such a work as that under notice acceptable in the highest degree. The author has wisely avoided the encyclopædic treatment of the science, but at the same time has, we think, supplied adequate definitions for the purpose. In many cases considerably more than a bare definition of a term is given. For example, under the heading "Air Condenser" we find not only a brief definition of the term, but also a rule for the capacity of an air condenser in farads, and an illustrated method of constructing the apparatus. It may be stated that each title or subject is defined only once in the text, and while duplication of matter has been avoided, it thus causes many definitions to appear short. But by the assistance of the reader's own general knowledge, and by referring to the index, almost any subject can be found treated in all its aspects. Where a title is synonymous with one or more others, the definition is only given under one title, and the others appear at the foot of the article as synonyms. If the reader is seeking the definition of one of these synonyms, a reference to the index will show him at once what page contains the information sought for. Where a title embraces several words, all orders of the words are cited in the index; and to make the operation of finding references easy this plan has been carried out very fully. An excellent feature is the number of illustrations given, which considerably enhance the value of a book of this kind. We have found the work very complete and reliable, and can, therefore, commend it heartily.

Buildings and Structures of American Railroads: A Reference Book for Railroad Managers, Superintendents, Master Mechanics, Engineers, Architects, and Students. By Walter G. Berg. New York: John Wiley and Sons. London: Gay and Bird.

Mr. Berg, the author of this voluminous work, is the principal assistant engineer of the Lehigh Valley Railroad, and has from time to time contributed serial articles on the subject to the American technical journals. There can be no doubt that both in this country and America literature dealing with railroad buildings, maintenance of permanent way, and the operating departments of railroads, is very scarce indeed. With the exception of a few articles which have appeared in the technical periodicals, and which when required are invariably difficult to trace, there is practically no information available to those outside the official departments of the various lines. The want of a work of the kind under notice is, therefore, a real one, and we are pleased to be able to say that Mr. Berg has fully met the requirements of those who desire to obtain reliable data bearing upon the present practice in American railroad structures. In his preface the author explains that his aim has been to present a collection embodying the best practice for each particular class of structure, whether cheap or expensive, and showing the sundry variations caused by individual views or local conditions in different sections of the country. Particular attention has been given to the smaller buildings connected with the roadway and operating departments, and the cheap and simple structures in use in the thinly-settled sections of the country have been considered of as much importance as those of the most elaborate and artistic design. It may be mentioned that each subject is discussed in a general manner at the beginning of the corresponding chapter, so that inexperienced persons can gain information on the salient points and controlling features for each class of structures, while others more conversant with the subject will find these general discussions convenient for reference. The second part of each chapter is devoted to detailed descriptions and illustrations of structures in use on American railroads. Some idea of the scope of the work will be obtained from the statement that over five hundred different buildings and structures are described or referred to, while nearly seven hundred illustrations accompany the text. There is no doubt that the work will occupy the high position in railroad literature that it deserves, and that it will long remain the standard work on the subject. Both Mr. Berg and Messrs. Wiley and Sons, the publishers, are certainly to be congratulated upon the general excellence of the production.

Slide-rule Instructor. By John Chadwick. Manchester: John Heywood. 2s.

This work is put forward as containing new and important rules upon the present practice of engineering, and is apparently intended to be used with Chadwick's improved slide rule. While, however, admitting that the little volume is a great improvement upon most of the slide-rule companions, we must confess that we are to some extent disappointed with the results of Mr. Chadwick's efforts. Some of the examples, for instance, appear to us to be ill-chosen. Present-day engineers who make use of the slide rule, do not care for such exercises as those given on p. 14—*e.g.*, What cost 280 gross of tape at 6s. 9d. per gross? What cost 240 umbrellas at 7s. 3d. each? etc. There are many useful rules and formulæ in constant request by engineers and draughtsmen, examples of which might be substituted for such as those above cited with considerable advantage. A special feature of the improved slide rule is the provision of a scale of hyperbolic logarithms on the back of the brass slide. It appears that this scale is furnished specially to enable the mean pressure of expanding steam to be obtained from the formula $\frac{1 + \text{hyp. log. } r}{r}$. Since hyperbolic logarithms are but little used in engineering practice other than for the purpose named, it seems to us that the same end might have been much more readily attained by simply giving a scale of gauge points on the back of the slide, which would enable the mean pressure to be at once read off without performing a somewhat complicated and withal unnecessary operation. We have detected very few errors in the work. There is, however, a mistake in the last example but one on p. 15, the second line of the instructions obviously belonging to the next example; also we find a footnote on p. 22 which is referred to in the previous page. In conclusion we may say that the work is a distinct advance upon the usual type of slide-rule handbook, although it still leaves much to be desired.

Electrical Experiments: A Manual of Instructive Amusement. By G. E. Bonney. London: Whittaker and Co.

To those who wish for simple instructions for making electrical apparatus and directions for performing experiments with it when constructed, the work under notice may be specially commended. Mr. Bonney is the author of several reliable works on electrical apparatus, and is therefore well qualified to prepare an elementary and popular manual such as is here presented. The book is divided into six sections, dealing respectively with magnetic experiments, experiments with electro-magnets, experiments with induction coils, experiments with static electricity, electrolytic experiments, and miscellaneous electrical experiments. The book, we may add, is very fully illustrated.

Original Papers on Dynamo Machinery and Allied Subjects. By Dr. John Hopkinson. London: Whittaker and Co. New York: The W. J. Johnston Company Limited.

This volume contains a collection of papers by Dr. John Hopkinson on electro-technical subjects, and comprises five papers on the continuous-current dynamo, four on converters, a note on the theory of alternate-current machines, and a paper on the applications of electricity to lighthouses. We are sure that all students of electrical science will welcome this volume, while it will also prove of service to electrical engineers generally.

We have also received:—"The British and French Calculator," by John Williams (published by the author, Thorpe-road, Walsall; 2s.); a useful little work, giving the comparative values of English and French quotations at any rate of exchange; also exchange tables and tables for the conversion of metrical weights and measures into English, and *vice versâ*.—"Description of the Electric-light Installation at the Peel Mills, Bury," and "Notes on Town Lighting" (J. Holmes and Co., Newcastle-on-Tyne).—"The Standard Guide to Chicago" (The Standard Guide Company, Chicago). This volume contains a very complete account of the city of Chicago, and comprises at once a history, an encyclopædia, and a guide. It is embellished with quite a number of capital illustrations of the various public buildings, and also contains a large map of the city. Intending visitors to the World's Fair will do well to procure a copy of this work.—With the March monthly part of "Work" (Messrs. Cassell and Co. Limited; 6d. monthly, 1d. weekly), a new and enlarged series is commenced. The very useful papers found in this issue include: Capital and Labour Men, Design and Decoration of All Ages, Links in the History of Electrical Science, How to Make a Galvanometer, The Sewing Machine, The Telescope, etc.

Trade Notes.

The directors of the United Asbestos Company Limited recommend a dividend of 5 per cent. on the ordinary shares.

Messrs. M'Onie, Harvey and Co., of Glasgow, have just completed a quantity of sugar machinery for a plantation in Peru.

The John Cockerill Company, of Liege, Belgium, have secured an order for 3600 tons of steel rails from the Madrid and Alicante Railway.

Messrs. H. Vickers, Sons and Co., of the River Don Works, Sheffield, are erecting a forging press which, it is stated, will exert a pressure of 6000 tons when completed.

Messrs. Andrew Handyside and Co. Limited, of Derby, have secured the contract to supply the girder for the 15-ton block-setting crane for use at the South Pier, Sunderland.

The Hanover Engineering Company, and the Hohenzollern Engineering Company, of Düsseldorf, have received orders for 25 and 15 locomotives respectively for the German State railways.

Messrs. William Arrol and Co., Dalmarnock Ironworks, intimate that the designation of the firm in future will be Sir William Arrol and Co. There is no alteration in the constitution of the firm.

Messrs. Samuel Osborne and Co., Clyde Steel and Iron Works, Sheffield, intimate that they have decided in future to mark all their files either "machine-cut" or "hand-cut," as the case may be.

Messrs. Hugh Smith and Co., Possilpark, Glasgow, are constructing an hydraulic machine for shearing the ends of heavy angle and channel bars for Messrs. William Denny and Bros., Dumbarton.

Messrs. William Beardmore and Co., Parkhead Forge, Glasgow, have set in operation a new rolling mill, which is said to be the largest of its kind in Scotland, having a productive capacity of 100 tons per day.

The Patent Shaft and Axletree Company, Wednesbury, have started a portion of their new steel-making plant. The engine of 4000H.P. and the mill for making steel channels are now in working order.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 65, Strand, London, or New Bridge-street, Manchester.

Having regard to the enormous circulation of The Mechanical World, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if Mechanical World readers will kindly bear this in mind as occasion arises.

Marine Boiler Furnaces.

(Concluded from page 88.)

FACTORS OF SAFETY.

THE furnace manufacture for the mercantile marine of this country is under the absolute control of the Board of Trade and Lloyd's Registry, as not only do these authorities determine the limits of the tensile strength of the steel to be used, but by formulating rules for the strength of furnaces they also control the weight and consequently the commercial value of every type of furnace used in marine boilers.

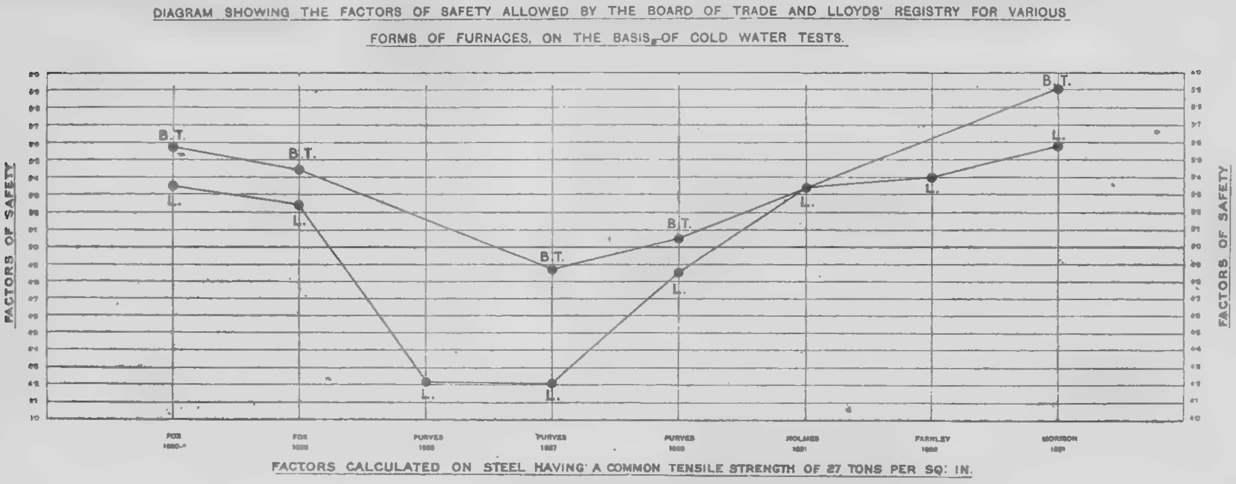


FIG. 17.

The importance of the furnace manufacture may be estimated from the fact that the Leeds Forge Company have made over 30,000 corrugated furnaces, while Messrs. John Brown and Co., of Sheffield, have made 10,000 of the Purves design. Until recent years, or since the general adoption of triple-expansion engines, the types of special furnaces were but few. The demand for improvement, however, has resulted in other designs, and the increasing severity and accuracy of the Board of Trade tests may be explained by the desire to give each design proportionate value. The factors of safety have been formed by dividing the actual collapsing pressures under cold-water test by the working pressures allowed by the Board of Trade and Lloyd's rules. Factor of safety

$$= \frac{\text{actual collapsing pressure}}{\text{pressure given by formula}}.$$

The fluctuations of the factors of safety required at different times for the same furnace, and at the same time for different furnaces, are shown by Fig. 17. In 1891 the Board of Trade required a factor for the Fox furnace of 5·58, and in 1892 it was 5·44. For the Purves furnace the factor in 1888 was 4·87, and in 1890 it was 5 05, whilst the Morison furnace has a provisional factor of 5·91.

Lloyd's factors also vary considerably. In 1891 the Fox factor was 5·35, and in 1892 it was 5·24. The factor of the Purves furnace in 1888 was only 4·21; in 1889, 4·21; and in 1890, 4 85. The Holmes furnace requires 5·34; the Farnley, 5·39; and the Suspension, 5·58.

These furnaces, being all of high tensile steel, cannot be directly compared with the first of the Fox furnace in 1882. The larger factors now demanded seem to indicate a decrease of confidence in steel of the high-tensile strength, such as has lately been used. The Board of Trade have now adopted the standard dimension of the least external diameter as a basis for their formula for all furnaces, and as the least internal diameter is a measure of the effective width of grate, this dimension seems very suitable and convenient. Lloyd's formula requires in the case of the Fox, Farnley, and Morison furnaces the greatest external diameter, and for the Purves, Holmes, and Adamson the least external diameter. This difference causes a difficulty in directly comparing the constants allowed for different furnaces, and a standard dimension of the least external diameter would be a great improvement.

MATERIAL.

It is impossible to over-estimate the value of determining the quality of steel most suitable for the manufacture of boiler furnace tubes of modern high-pressure boilers, as suitability of material is the first essential to practical success. On the introduction of the corrugated furnace in 1882, the manufacturers considered that a steel of low tensile and high elongation was the best for the general requirements of a furnace, and the fact that at the Leeds Forge alone 28,000 furnaces have been made of steel under 26 tons tensile, and that in 1888 the Engineer-in-Chief of the Board of Trade should have written the following in his work on "Boiler Construction," is a sufficient proof that their views were correct. Mr. Trail says:—"Up to this time (1888) it is not known that any serious casualty has resulted from a collapse of a corrugated furnace, although some have come down, but when this has been the case the plates, it is believed, have been overheated, due to dirt or other easily-assigned cause not attributable to defects in the furnace, and such deformations as have taken place would have been of a much more serious nature had the furnace been plain instead of corrugated." Mr. Trail also foreshadows a modification of the Fox design, such as the Suspension furnace, as he says: "There is still a good deal of vitality in the corrugated furnace, and possibly its special advantages may yet be improved upon, and so give it new life to compete successfully with any that may come into the market against it." The Board of Trade regulations for furnace steel are that it should not be less than 26 tons tensile strength and should not exceed 30 tons, and recognise 28 tons per square inch, with an elongation of not less than 20 per cent. in 10in., as a good tensile strength such as is suitable for furnaces. Lloyd's also recognise steel of from 26 to 30 tons as suitable for furnaces. The English Admiralty, whose experience with corrugated furnaces of low tensile has been remarkably successful, now specify that the tensile strength of steel for furnaces must not exceed 25 tons, with an elongation of not less than 27 per cent. in 8in. All Continental governments also use steel under 26 tons for furnaces, and the U.S. Government requires the tensile to be from 50,000 to 60,000lb., or 22·3 to 26·8 tons per square inch. The tensile of the Purves flue has always been from 26 to 30 tons for the mercantile marine; consequently, from a commercial point of view, the Leeds Forge Company were compelled to raise their standard tensile, and since 1890 practically all furnaces for the mercantile marine have been made of steel having an average tensile of 28 tons, or 4 tons higher than the standard adopted by the Leeds Forge Company prior to that date, and 4 tons higher than the requirements of the English and foreign governments. The all-important question is, therefore, Have furnaces made from steel of from 26 to 30 tons tensile been as successful as those made from 23 to 26 tons? The writer has lately consulted with many eminent engineers on this important subject, and the general opinion undoubtedly is that we pay too dearly for the lighter furnaces of the harder material, and the fact that the percentage of failures is now greater than ever before has caused a feeling in favour of softer material, or, in other words, that steel having a tensile strength not exceeding 26 tons, with an elongation of 25 per cent. in 8in., is more suitable for furnaces than steel having a tensile strength not exceeding 30 tons. The advantages for the lower standard are, in the writer's opinion:—It is better able to stand the rough usage of an ordinary boiler shop. It is less liable to develop small cracks in manufacture which may pass unnoticed and afterwards extend. It is more ductile and will stand the continued expansion and contraction incidental to a steam boiler better than high tensile. It will remain longer ductile than the harder steel. It will also be less liable to crack at the back ends. In fact, the only point which is apparently in favour of the high tensile is that the first cost of the furnace is slightly less, although the result is uncertainty of material and the probable shortened life of the furnace.

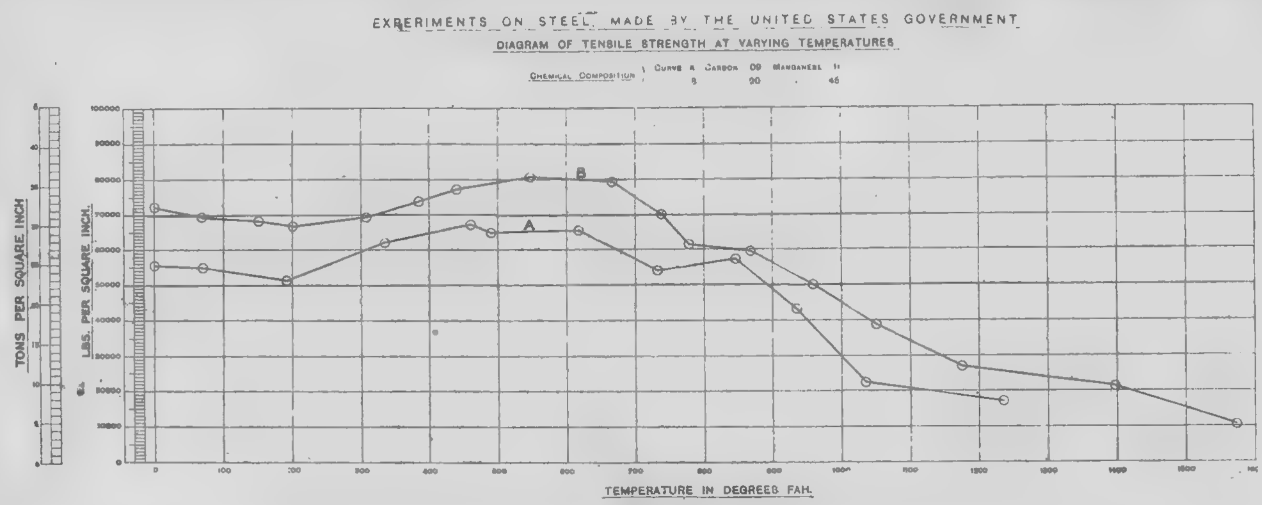


FIG. 18.

TEMPERATURE.

The influence of temperature upon the strength and ductility of mild steel does not seem to have had the attention that the subject merits. There is considerable uncertainty as to the exact temperature of the material of a furnace under actual working condition; but the experiments made by the late Dr. A. C. Kirk have determined it with approximate accuracy. (See "Engineering," July 15 and September 9, 1892.)

Dr. Kirk aimed at finding the temperature of the fire side of tube plates of various thicknesses, the upper side of which was covered with water, which was allowed to boil at atmospheric pressure. The results of the experiments are shown graphically in Fig. 22, the abscissæ representing thickness of tube plate and the normals the temperature of the fire side of the plate above 212° F. A fair curve is drawn through the mean of the results. With a clean plate 1in. thick the temperature of the fire side was found to exceed that of the water side by 294° F., while with ½in. plate the difference under the same conditions was only 88° F.

With a temperature on the water side of 380° F., corresponding to a steam pressure of 180lb. per square inch, the temperature on the fire side of an inch plate would be 670°, and with a ½in. plate 468° F.

The diagram shows that the difference in temperature increases from 88° F. with a ½in. plate to 588° F. with a 2¾in. plate.

It may be noted that the results are not so reliable for very thick plates, but within the limits of thickness used in practice they are sufficiently accurate.

The thickness of the plate of which a furnace is formed has a most material influence upon the temperature of the furnace, and as in practice the thickness varies between the limits of ½in. and 1in. it may be assumed that the temperature (when the furnaces are clean and have no scale) is between 468° and 670° F.

The influence of temperature upon the behaviour of mild steel under tension is shown by a splendid set of experiments made with the United States testing machine in 1888, from which the diagrams, Figs. 18, 19, and 20, have been copied.

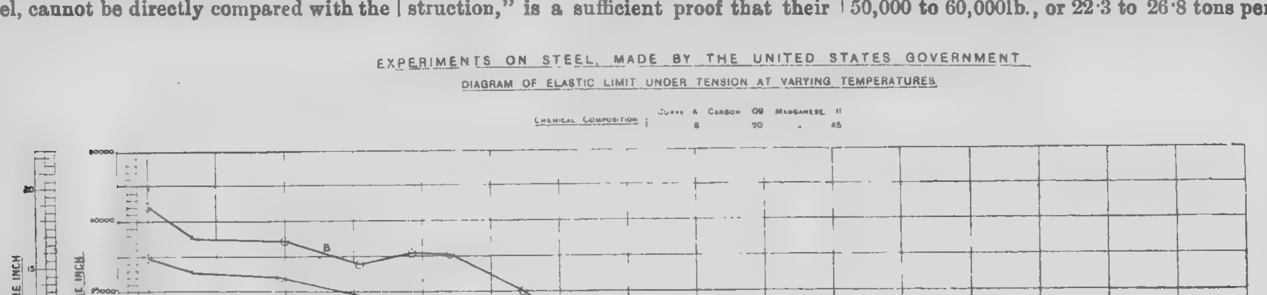


FIG. 19.

Briefly, the results shown by these experiments are—that the tensile strength of all steel decreases from zero F. to a temperature of 200° to 300° F. This is followed by an increase, and the maximum tensile strength is reached at about 400° F. to 600° F. Beyond this latter temperature the strength decreases rapidly.

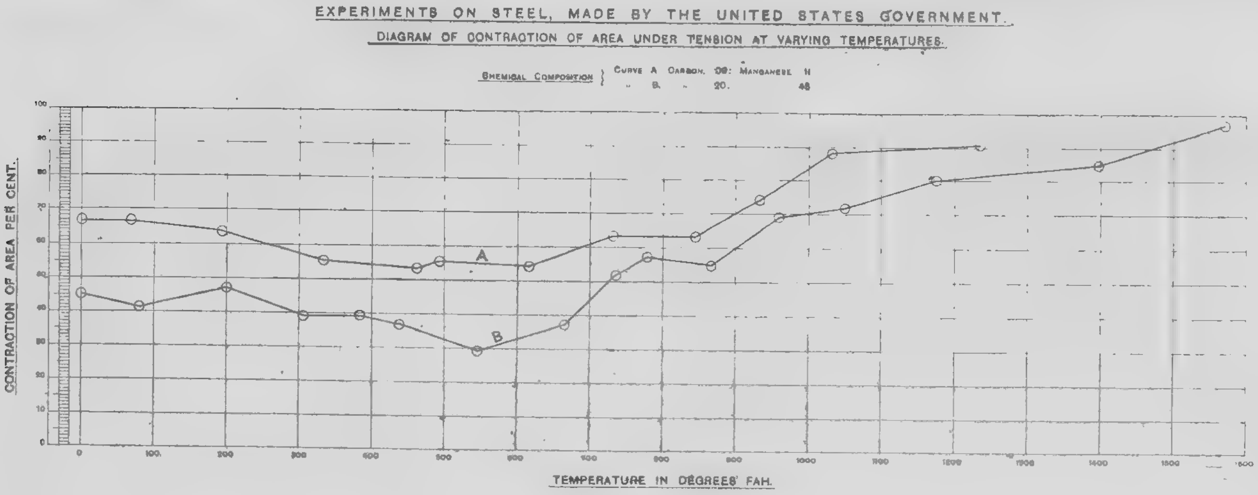


Fig. 20.

Although the ultimate tensile strength of the steel increases between 200° F. and 600° F., the elastic limit steadily decreases from zero F. upwards, and steel having an elastic limit of 35,000lb. per square inch at zero, has its elastic limit reduced to 20,000lb. per square inch at 600° F.

It is also found that between zero and 550° F. all steels show decided yielding at loads below the elastic limit, and that after this yielding takes places it may go on even with slightly reduced loads. This is especially the case with mild steels, such as are used for the manufacture of furnaces.

Another point is, that the higher carbon steels reach the temperature of maximum strength more abruptly, and retain their highest strength over a less range of temperature than steels having a low percentage of carbon.

The ductility of steel also varies with the temperature. This is shown by Fig. 20, which represents the contraction of area at the point of fracture for various temperatures. There is a tendency to fracture with less contraction of area up to a temperature of 400° to 600° F. In the vicinity of this range of temperature a number of the bars fractured obliquely across their stems instead of at right angles as at higher and lower temperatures. This behaviour is significant, and appears to connect the tensile tests with the brittleness which is also observed in bending tests at these temperatures.

The influence of temperature upon steel may be summarised as follows:—With a thick furnace the temperature of the plate will be higher than with a thin one, and consequently the elastic limit will be lower, and there will be a liability to sag unless the factor of safety is very high in the first instance. With thin furnaces, say about ½ to ⅝in. thick and 180lb. pressure of steam, the temperature of the inner surface of furnace plate, which is clean on the water side, is 470°, and consequently about the brittle temperature. It is therefore necessary to guard against this brittleness by employing steel of low tensile strength, as the lower carbon steels retain their maximum strength and ductility over a greater range of temperature than the higher carbon steels.

[Mr. Morrison here gave an extract from the interesting paper by Herr Von Knaudt on "Experiments Made to Determine the Longitudinal Elasticity of various Designs of Furnaces." A very full translation of this paper was given in The Mechanical World for January 13 last, to which our readers are referred.—Ed. M. W.]

Accidents to furnaces generally result from collapse, the development of small cracks along the line of fire, circumferential ripping in the body of the furnace, and the ripping at the back ends, usually starting from the flanged corners. Neglecting shortness of water, collapse of furnaces is generally due to accumulation, either of scale or of oily deposit, and may be prevented by the use of evaporators and feed-water filters. The development of small cracks along the line of fire is caused by local overheating of the materials due to undue accumulation of deposit. The inward projections of the Fox furnace, for example, are towards the fire, and by receiving the greatest heat cause an undue accumulation of scale in the narrow pocket or cavity formed by the inward corrugation, with the result that the crowns of the corrugations get overheated and sometimes crack. These cracks also occur in the Purves, but generally on or near to the thickened ribs. The most serious form of cracking, however, is the sudden and unexpected ripping of a furnace, either circumferentially in the body or at the back end, these cracks sometimes extending for 18in., and completely destroying the furnace. This form of accident can, in the writer's opinion, be avoided by the design and manufacture of the furnace, the disposition of the stays, and the suitability of material. It should never be lost sight of when designing the flanged end of a furnace that, the greater work put upon the material during its manufacture, the greater is the danger of ultimate failure by cracking. It is also known that certain movements of the furnace result from expansion and contraction, consequently if these movements are concentrated at points and not distributed uniformly over the length of the furnace, then if the furnace cracks it will be at the weakest point of concentration. Accidents of this nature have also been caused by the leakage of feed-circulating devices fixed in the boiler bottom. The disposition of stays also appears of importance, as a furnace must and will move; consequently, if the tubes are kept too low, the saddle short, or the furnace stayed in all directions, with stays arranged very near to the surface of the furnace, the very feature of the utmost value—viz., longitudinal elasticity—is entirely neutralised. If it is desired to surround a furnace with stays they should, in the writer's opinion, be a slack fit longitudinally. Regarding material, it has been seen that high-tensile steel does not remain ductile so long as low-tensile; also, that the tensile when under working conditions is greater than when cold. Further, at the temperature of working condition the steel is at the point of uncertainty, or the point of the greatest brittleness, consequently the writer would again say that steel not exceeding 26 tons tensile strength is more suitable for furnaces than steel not exceeding 30 tons.

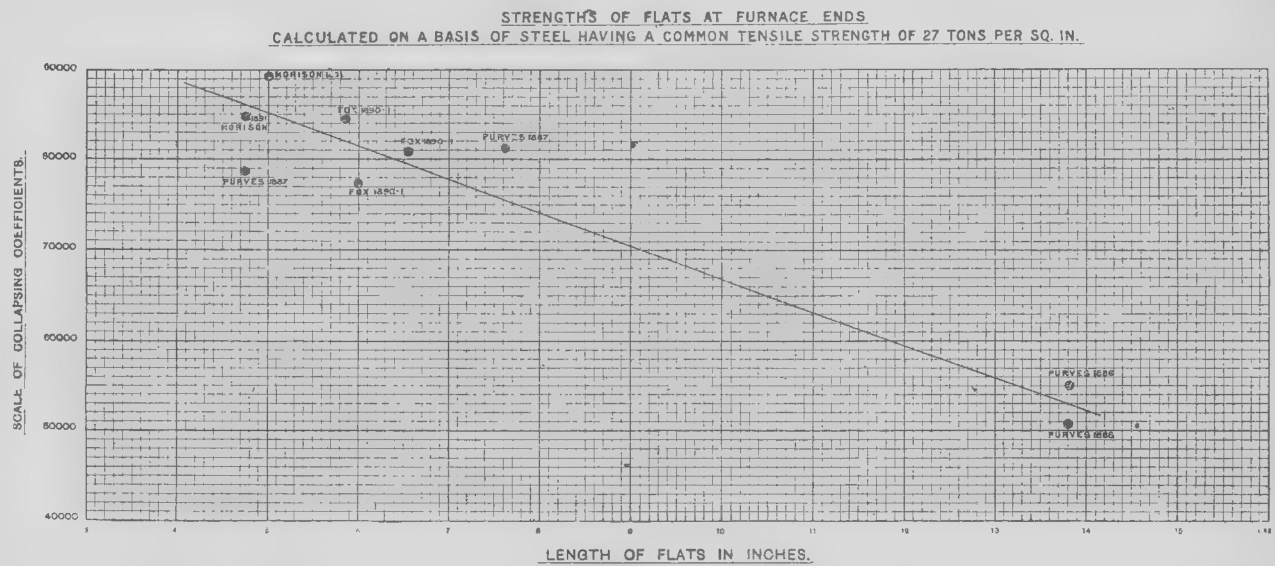


Fig. 21.

It is also certain that the highest quality of steel of any tensile cannot be obtained without the use of the best materials, and excess of phosphorus and sulphur should never be present in steel which has to be subjected to such severe treatment as in a furnace. The design of flanged corners of the saddle, and also the radius between the saddle and the furnace, would also seem to affect the ultimate result. If uniform elasticity of design is essential to ultimate success, then these curves should be easy and not sharp and abrupt. These are all practical questions, however, upon which a broad discussion will be of the utmost value.

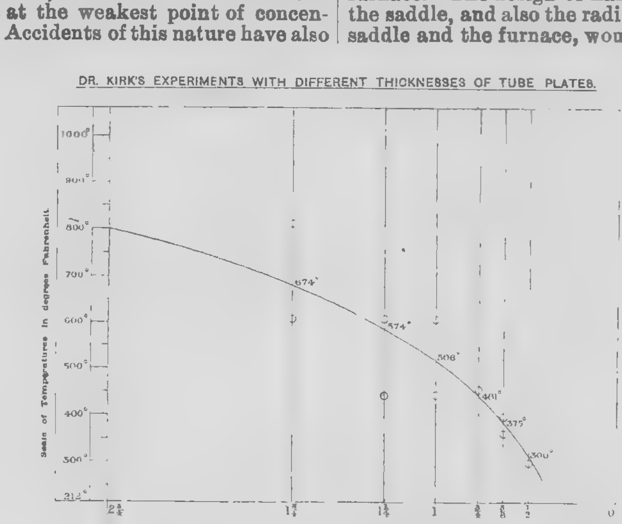


Fig. 22.

In conclusion, the writer desires to thank the various firms who have placed data at his disposal—viz., Messrs. T. Richardson and Sons, of Hartlepool; the Leeds Forge Company, of Leeds; Sir John Brown and Co., of Sheffield; the Farnley Iron Company, of Leeds; Messrs. Howden and Co., of Glasgow; Messrs. Charles D. Holmes and Co., of Hull; and Messrs. Hall, Russell and Co., of Aberdeen. The paper by Herr Von Knaudt, of Essen, has also supplied the valuable experiment in the longitudinal elasticity, and the temperature tests by the United States Government are certainly the most accurate and most valuable ever compiled, and reflect the greatest possible credit on the officials by whom they were made.

The "Camel" Belting Case.

REDDAWAY *v.* FLEMING.

This action came on for trial before Mr. Justice Mathew, at the High Court of Justice, London, on Monday, February 27. Sir R. E. Webster, Q.C., M.P., Mr. Moulton, Q.C., and Mr. J. C. Graham (instructed by Mr. A. Macdonald Blair, solicitor, Manchester), appeared for the plaintiff; and Mr. Cohen, Q.C., and Mr. Terrell (instructed by Mr. Boocock, solicitor, Halifax), appeared for the defendant.

The following is a transcript of the proceedings:—Mr. Graham: I appear, my Lord, in this case for the plaintiff. My friend Mr. Moulton is just coming here, and as it is a matter of some little importance perhaps your Lordship will allow me to wait a moment.—Mr. T. Terrell: I appear for the defendant. I do not think it is necessary, because I am instructed to consent to judgment.—Mr. Justice Mathew: I think that will do. A consent to judgment is always accepted readily.—Mr. Graham: This, I think, is the third occasion on which, not this defendant, but other defendants, have given way before the trial. We have been put to great expense on questions of this kind, and we want now to have it stated publicly so that defendants may know in future that they cannot go on doing what they have been doing before.—Mr. Justice Mathew: Why should not you tell me in confidence about that?—Mr. Graham: Because Mr. Moulton will be here in one moment and he will do it so much better. Mr. Justice Mathew: You must kindly tell me what the nature of the complaint is.

Mr. Graham: My Lord, this was an action which was commenced to restrain the defendant from using the word "Camel" in connection with the sale of belting in such a way as to mislead the public into the belief that they were buying the plaintiff's belting. My Lord, the facts very shortly are that about 12 or 14 years ago the plaintiff first began to make use of the word "Camel" in connection with belting, and he used it very extensively both in this country and in foreign countries, and from the date when he first began to use it down to about two years ago, I believe he was the only person who made use of the word "Camel" in connection with the sale of belting. About two years ago other persons began to use the word also, and the plaintiff complained of this and brought actions against three other gentlemen, I think, but they successively gave way. The consequence was that Messrs. Reddaway never had the opportunity of stating their case in court. The last gentleman who infringed was the defendant in this case,

and after putting us to an enormous expense in getting up this case at the eleventh hour, he has given way also. Perhaps your Lordship will allow my friend Mr. Moulton, who is here, to go on.—Mr. Justice Mathew: No, no.—Mr. Graham: Then, my Lord, that being the case, what the plaintiff is anxious to do is to have acknowledged publicly that he is the person who is solely entitled to the use of the word "Camel," or, to put it perhaps more clearly, that no other person can walk into the market and use the word "Camel" in such a way as to deprive him of the reputation he has established for himself, not only here, but in India and China and the Colonies. My Lord, there was no pretence of a compromise as far as the plaintiff is concerned. It is an absolute——.—Mr. Justice Mathew: Surrender.—Mr. Graham: Yes, it is an absolute surrender on the part of the defendant. He has agreed to terms, and perhaps your Lordship will allow me to read the terms upon which he has agreed to submit. He consents to an injunction in the terms of the statement of claim and for an account, or to pay to the plaintiff damages, and undertakes to pay the plaintiff's taxed costs as between party and party in the action, including the costs for the motion for injunction and costs of the appeal from the Divisional Court to the Court of Appeal, and plaintiff's summons for commission to India, and any costs that may have been reserved, and to waive all costs ordered to be paid by plaintiff in any event, and to pay plaintiff's costs in any application in which plaintiffs was ordered to pay defendants' costs, except on the appeal from Mr. Justice Bruce to the Divisional Court. Then comes something I need not read. Mr. Fleming to use his endeavours to induce certain other persons "to give an undertaking not to advertise or sell belting as 'Camel,' 'Camel Hair,' or 'Camel Brand' in such a manner as to pass off their goods as and for the goods of the plaintiff's manufacture." —Mr. Justice Mathew: Very well, there is a complete surrender. You have the opportunity of stating that for the third time. That is so.—Mr. Terrell: My Lord, I am instructed to consent to these terms, that is all.—Mr. Justice Mathew: Very well; that is, I should say, a very satisfactory ending of the case for the plaintiff.—Mr. Graham: Then it will be a judgment for the plaintiff, on those terms?—Mr. Justice Mathew: Yes.

Junior Engineering Society, New Swindon.

The first meeting of the above newly-formed society took place in the Lecture Hall of the Mechanics' Institute on February 17. Mr. A. E. Leader presided, and after the proposed rules had been read and passed, the meeting elected the officers and committee of the society as follows:—Chairman and treasurer, Mr. A. E. Leader; committee, Messrs. W. R. Bird, C. Davison, H. G. Cotsworth, F. W. Spooner, W. L. Holt, L. Dyer, H. Harvie, and J. Ford; hon. sec., Mr. E. G. Ireland. The society meet for the usual reading and discussion of papers on engineering subjects, and it is hoped that excursions to places of interest may be arranged during the summer.

On February 24 Mr. H. G. Cotsworth presided over a well-attended meeting of the society. Mr. A. E. Leader read a very useful and interesting paper, entitled "Lubrication," in which he demonstrated the necessity for and principles of good lubrication, and discussed the merits and demerits of the principal lubricants in use. With the aid of excellent drawings he described and explained the best-known forms of lubricators used in modern practice, also a lubricant-testing machine, with method of testing oils, etc.

On March 4 another most successful meeting was held, presided over by Mr. A. E. Leader, who introduced Mr. T. C. Davison, Whitworth Exhibitioner, who read a very instructive paper on "Indicator Diagrams," in the course of which he described theoretically-perfect, also some exceptionally-misformed diagrams, giving interesting reasons for the pulsations of pressure indicated in some by the wavy form of the diagrams, and effects of constructional defects in machinery and apparatus on same. Messrs. Stephens, Moon and Bird ably assisted in the discussion which followed, with relations of their experiences in taking diagrams and the merits of the indicators used.

The transportation of large quantities of mail matter by pneumatic tubes is to be tried between the post-offices of New York and Brooklyn, U.S.A.

Metal Trade Memoranda.

The output of ore from the Marbella Iron Ore Company's Mines during the month of February was 4263 tons.

Plant is being put down at the Redcar Ironworks for the manufacture of slag bricks. Similar plants are in operation at the Cargo Fleet and the Lackenby Ironworks.

The metal mixer which has been in operation for some time at the Eston Works of Messrs. Bolckow, Vaughan and Co. has proved so satisfactory that they are erecting a second one.

The steel angle mills now in course of erection at the Consett Iron and Steel Company's Works are nearly completed. It is expected that this department will be in operation by the middle of this month.

Last year the total production of steel and ingot iron from phosphoric pig by the Thomas-Gilchrist process amounted to 3,202,640 tons, or 322,105 tons more than in 1891. Of this total 2,591,374 tons were of basic Bessemer metal, and 611,266 tons of basic open-hearth steel.

New Companies.

London and Lancashire Electric and General Engineering Company Limited.—This company was registered on the 27th ult., with a capital of £20,000, in £5 shares, to acquire the property and effects of the business of electrical engineers now carried on by W. R. Pryke and Wm. Palmer, under the style of the London and Lancashire Electric Company; to enter into a certain agreement to supply electricity and to carry on the business of electricians in all its branches. The rules of Table A are usually applicable. Registered by J. D. Peard, 13, Sise-lane, E.C.

Yeadon American Gas Retort Syndicate Limited.—This company was registered on the 27th ult., with a capital of £2000, in £5 shares, to purchase or otherwise acquire the patent No. 477,286, under the seal of the Patent Office of the U.S.A., belonging to J. A. Yeadon, Wm. Adjie, J. Hardcastle, Wm. Kettlewell, J. Franks, and W. A. Hobson, for new and useful improvements in retort furnaces, and to extend and develop such a business. The first directors are to be the gentlemen to whom the patent belongs. The rules of Table A mostly apply. Registered office, 4, Albion-place, Leeds.

Jones's Patent Steel Company Limited.—This company was registered on the 28th ult., with a capital of £10,000, in £5 shares, to buy, sell, manufacture, purify, cast, recast, improve, convert, and deal in steel and all substances and things capable of being used in the manufacture or conversion of steel; to carry on the business of metal workers, metallurgists, founders, miners, smelters, colliery proprietors, mechanical engineers, coke and fuel manufacturers, and coal merchants. Until otherwise determined, the number of directors is not to be more than 5, nor less than 3; the first being H. Hill, C. Jones, and W. E. Woolley; qualification, £50; remuneration, £30 per annum when there are three directors, £10 per year in respect of each additional director, and certain percentage. Registered office, 1, Great Winchester-street, E.C.

Mazarron Electric Light Company Limited.—This company was registered on the 27th ult., with a capital of £15,000, in £1 shares, to establish electric lighting for the town of Mazarron, in the province of Murcia, Spain, or elsewhere, and to acquire a concession dated September 6, 1892, granted to Mr. Santiago Olivera y Bazterrica, of Mazarron; to enter and carry into effect a certain agreement, and to generate or produce electricity and electric force, and to distribute the same; to light public or private buildings in all parts of the world; and to deal in apparatus and instruments for electric lighting. The number of directors is not to be less than 2, nor more than 5; qualification, £10; the first directors, who need not hold any qualification, are to be W. B. Kingsford and S. W. Richards; remuneration, £50 per annum each, and 5 per cent. on the amount applicable to dividend to the ordinary shareholders. Registered by Romer and Haslam, 4, Copthall Chambers, E.C.

American River Electric Power Supply Company Limited.—This company was registered on the 28th ult., with a capital of £95,000, in £1 shares, to enter into, adopt, and carry into effect a certain agreement dated February 24, 1893, and made between the American River Syndicate Limited, of the first part; Wm. Smith, the liquidator of this syndicate, of the second part, and Harry Ward, as trustee for the company, of the third part; to carry on the business of electricians, electrical engineers, generators of and dealers in electrical motive power and light, and to produce, store, and accumulate electricity, electrical motive force, or similar agency. The number of directors is not to be less than 2, nor more than 7; the following being the first:—Viscount Grimstone, F. Retallack, Commander O. Young, R.N.; J. Taylor, C.E., and G. C. Pearson; qualification, 10 shares; remuneration, £30 per annum, and 5 per cent. on the surplus profits after payment of a 10 per cent. dividend on the ordinary shares. Registered by Lyne and Holman, 5 and 6, Great Winchester-street, E.C.

The Metal Market.

PRICES CURRENT.

LONDON, March 6.

Copper had a steady market during early trading, buyers only getting an advantage of a few days towards the close of the first session, without change in price, which for cash was £45 10s., and for three months £45 18s. 9d. Later in the day, with offerings light and buying better, three months made £46, and cash £45 11s. 3d., the market closing firm at 1s. 3d. advance. Sales, 800 to 900 tons. Settlement price, £45 10s. English tough, £48 15s.; best selected, £50; strong sheets, £57 to £57 10s.

Tin opened firm and fully 5s. above Friday's latest values, and developed strength, three months moving at £93 to £93 10s., two months at £93 and £93 10s., and early April at £93 5s. to £93 10s. during the first session, the advance being due to buying by operators for the rise, in view of the American duty coming into force, large houses taking a prominent part. This continued on a much larger scale in the afternoon without change in prices for some time, purchases being chiefly in two months. Three months, however, began to fall off towards the close. £93 7s. 6d. and then £93 2s. 6d. was accepted, while two months and thereabout made £93 10s.; and cash, which had sold early at £93, ruled at £93 5s., with end of March at £93 7s. 6d. The market was considerably excited, there being some adverse rumours after, and, with holders realising, a little short of three months was done on the kerb at £92 17s. 6d. to £92 15s., while cash was offered at £93 2s. 6d. Cash closed about 15s. better, but three months only about 7s. 6d. higher. Sales, 630 tons. Settlement price, £93 5s. English ingots, £96.

Pig Iron has ruled dull and featureless. Buyers advanced ½d. on Friday's values for cash; sellers, however, asking 40s. 7½d., business was hindered. Settlement prices:—Scotch, 40s. 6d.; Middlesbrough, 34s.; hematite, 46s.

Tinplates are no worse, and cheap lots are now being bought up.

Lead is steady at £9 17s. 6d. sellers, after business at £9 16s. 3d. English, £10.

Zinc Sheets.—Silesian steady, with ordinary at £20 15s. ex ship. Belgian quiet; V M brand, £20 17s. 6d. ex ship, and £20 15s. f.o.b. Antwerp.

Official Closing Quotations.

	To-day.					
	£	s.	d.	£	s.	d.
Copper—						
G. M. B.—Cash	45	11	3—	45	18	9
" Three months	46	0	0—	46	7	6
Tin—						
Fine foreign—Cash	93	5	0—	93	15	0
" " Three months	93	2	6—	93	12	6
Australian—Cash	93	10	0—	94	0	0
Pig Iron—					s.	d.
Scotch warrants—Cash					40	6½
" One month					40	8½
Middlesbrough—Cash					34	0
" One month					—	
Hematite—Cash					46	0
" One month					—	

GLASGOW, March 6.—This was a very idle day on the pig iron market. Only 1500 tons were sold. 500 tons Scotch and 1000 tons hematite, the former at 40s. 9½d. one month, and the latter at 46s. cash and 45s. 10d. three months fixed. The market closed with a very dull appearance. The shipments of Scotch last week were 5367 tons, being an increase on the corresponding week of 1687, leaving the decrease for the year 6375 tons.

Quotations:—

	Scotch.				Middlesbrough.				Hematite.			
	Cash.		1 m'th.		Cash.		1 m'th.		Cash.		1 m'th.	
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
Highest	40	7½	40	9½	34	0	—		46	0	—	
Lowest	40	6½	40	8½	34	0	—		45	9	—	
Close	40	7½	40	9½	34	0	—		46	0	—	
Prev. close	40	6	40	8½	34	1½	—		45	9	—	

Official Gazette.

Partnerships Dissolved.

R. P. Bolton and G. L. Davies, under the style of R. Bolton and Co., Leadenhall-street, E.C., engineers and merchants.

J. Elliott and T. Murgatroyd, owners of a patent for the protection of a mechanical appliance or arrangement for securing rails to their chairs upon the permanent way of railway companies.

W. Lord, Betsy Lord, and R. Lord (executors of the will of Simeon Lord, late of Bolton, ironfounder), under the style of William Lord and Son, Bolton, ironfounders and machinists; so far as regards William Lord.

THE BANKRUPTCY ACTS, 1883 and 1890.

Receiving Orders.

Richard Taylor, Leytonstone, metal merchant.

Frederick Silvester (trading as F. Silvester and Co.), Newcastle-under-Lyme, ironfounder.

Prize Competition.

We offer Four Guineas monthly in prizes for the best original Articles sent in on any Mechanical, Engineering or Electrical subject.

In order that Managers, Draughtsmen, Foremen, and Workmen who have had no practice in writing may not hesitate to send in competitions, it is to be understood that all articles will be fully edited and corrected, and judged of solely on their merits as original contributions from a practical point of view. The object of the competition is to induce practical men to come forward and give the results of their experience.

CONDITIONS.

Competitions for our Monthly Prizes must be sent so as to arrive at the Manchester Offices of The Mechanical World, New Bridge-street, not later than the last Tuesday in each month. Articles arriving after that time will be placed in the following month's competition.

Written competitions must be on one side of the paper only. The contributions must be original, and relate to matters connected with Engineering, Mechanism or Electricity.

The Proprietors of The Mechanical World reserve the right to publish any competition, whether it gains a prize or not.

The competitions may be accompanied by diagrams, sketches or drawings.

Competitors should write the words "Prize Competition" on the envelopes.

Competitors are not confined to one, but may send any number of competitions.

The correct name and address of the sender *must* be distinctly written upon every competition, not necessarily for publication. Competitions can appear under a *nom de plume*.

☞ We cannot undertake to be responsible for any MSS. sent to us, though when stamps are enclosed for the purpose we will endeavour to return rejected contributions.

Letters to the Editor.

*** *We do not hold ourselves responsible for opinions expressed by correspondents.*

*** *The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

*** *Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

THE "AVOIDANCE OF SMOKE."

To the Editor of The Mechanical World.

Sir,—In the interesting letter of Mr. T. Nicholson in your issue of the 24th Feb., he says "gas for heating purposes can be made in such a way as to leave a coke of far more value than ordinary gas coke, that the said gas will give more heat than the coal from which it is obtained does when burned in the ordinary way, and that Corporations of towns should make and supply both—the coke at 10s. per ton, and the gas at 6d. per 1000ft."

If by this it is meant that Corporations should supply illuminating gas through one set of pipes, and heating gas through another—as advocated at one time by Sir Wm. Siemens,—I am afraid Corporations, looking to the extent that electricity is likely to come into competition with gas for lighting in the future, will think many times before incurring the expense of another set of pipes.

As to large factories having a gas and coke plant of their own, Mr. Nicholson does not, I think, make it clear whether he advocates such to be used in connection with gas engines, or the existing steam engines; and if the latter, whether he would use in the furnaces, gas alone, or along with coke.

It is very pleasant to anticipate the time when there will not be a particle of smoke from any chimney, and when our tall chimneys will no longer be needed; but that time will not likely come until some non-smoke process is provided which will be more economical than those at present in vogue. W.

Glasgow, Feb. 27.

SAFETY VALVES FOR STATIONARY ENGINES.

To the Editor of The Mechanical World.

Sir,—A writer in a recent issue of The Mechanical World comments on the above, and gives first place to the Ramsbottom spring-loaded valve, remarking on its "great simplicity" and absence of opportunity for tampering. Now, sir, it just occurred to me that the writer of the article had not had a very extensive experience with the working of those valves, or he might not have been so definite in his description. It certainly is a simple valve, and for locomotive purposes perhaps the best valve made; but in my opinion it lends itself most readily either to ignorance or skilled malice, and is one of the easiest valves I know of to tamper with. The spring can be made nearly rigid by a simple appliance almost invisible to the observer. A wood plug, about 10in. of ⅛in. wire, two thimblesful of iron filings, or a few small shots, are all that is wanted to increase the load on the spring; while to take the valves out for regrinding very often entails a wrong loading of the valves. The weakness of the valve in these directions was soon found out, and the first thing Mr. Webb did was to put inspectors on to watch for this tampering, and the next was to encase them altogether, and even then they were not impregnable. I, myself, have seen them so arranged that they would blow at 120lb., but the lift of valve was so restricted that 140lb. or 150lb. could easily be reached, and only by the very closest inspection could the tampering be detected. Not long ago a locomotive was under repair, and the valves were removed and replaced, and owing to an ignorant fitter not replacing a washer under the bottom end of the spring the links were drawn tight, and the valves were locked to the face of the seatings. An explosion of the boiler occurred, which was put down to a weak firebox, those investigating the matter having taken it for granted that, being a Ramsbottom valve, it could not be tampered with; but a person who saw the valve after the explosion is quite sure the valves were locked hard and fast on the seating through the links having been drawn tight. It is, perhaps, not advisable to say too much in this direction, but having had much to do with them I think I know something about them, and could perhaps surprise the writer of the articles above referred to. RIVET.

Manchester, March 6.

Miscellaneous Items.

Small electric lamps have been tried with great success on the Dorsetshire sections of the Great Western and London and South-Western Railway Companies' systems.

It is intended to commence at Barrow the manufacture of steel barrels for the purpose of carrying petroleum. They are made in halves, and welded together by electricity.

In order to clean zinc, mix common whiting with ammonia until it forms a smooth paste, and apply to the zinc with a soft woollen cloth; when it becomes dry rub off with a piece of dry flannel.

The Mobile and Ohio Railway, U.S.A., have in use on their locomotives a special electric headlight. The carbons of the lamp are placed horizontally instead of vertically. A special kind of dynamo is used to supply current to the lamp.

A valuable discovery of gold has been made within 15 miles of the township of Salisbury, South Africa. The reef apparently forms part of the Mazoe gold belt. Five parallel lines of reef have been exposed, some of which are very rich and look permanent.

It is reported that petroleum oil of fine quality has been discovered on the grounds of a gentleman in Green Island, Belfast. Experiments lead to the assumption that springs of the valuable fluid exist, and the discovery is considered of the greatest importance for the North of Ireland.

The "Calais-Douvres," one of the London and Chatham Company's steamers, has recently made a very quick passage across the Channel. The time from pier to pier was exactly 1hr. 1min. This is equal to the best performances made by these boats when first put on this station.

The Shipwrights' Company have adopted a plan for the extension of its scheme for technical instruction in shipbuilding to Glasgow and Newcastle, arrangements having been entered into for that purpose with the universities of Glasgow and Durham. The company hopes to do the same in Liverpool and the other shipbuilding centres of the country.

A report recently published shows that for a period of seven years, 1884-1890 inclusive, the average number of fractures of steel tyres on the German railways was 0·28 per 100. On locomotive wheels the average was 0·50 per 100; tender wheels, 0·65 per 100; passenger carriage wheels, 0·38 per 100. In 1890 there were 30 accidents resulting from the breakage of tyres on the German lines. It is believed that many of the fractures are due to the fact that tyres are kept in service too long after they are worn down too thin for safety.

To fasten labels on glass, porcelain, and iron, take 120grms. of gum arabic, and 30grms. of gum tragacanth are macerated separately in a little water. The latter mixture is agitated until a viscous emulsion is formed, when the gum arabic solution is added and the whole filtered through fine linen. With this liquid is then incorporated 120grms. of glycerine, in which 2·5grms. oil of thyme have been dissolved. The volume is then made up to 1 litre by the addition of distilled water. This paste is said to possess remarkable adhesiveness, and to keep well in sealed flasks.

An important address on the principles and practice of arbitration was delivered on Tuesday evening week at St. James's Hall, London, before the Society of Architects, by Mr. Edgar Farman, solicitor to the society. After fully stating the present law upon the subject of arbitration, and dealing with the long-continued efforts which have been made in this direction, Mr. Farman pointed out that an arbitration before one of the London Chambers' arbitrators would in important cases often cost the successful party more than if he submitted to arbitration in the ordinary way. For while the fees of an arbitrator under the London Chamber are not limited by the schedule—an arbitrator being entitled, as at present, to refuse to act unless he is paid the sum he chooses to demand,—the successful party is saddled with certain costs, which the Chamber will not allow him to recover from the other side. Mr. Farman declared that this must seriously retard the general adoption of the Chamber for the purposes of arbitration.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ **Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.**

Iron Manufacture.—Required, particulars of the Husgafel process of making iron blooms direct from the ore.—F. C.

Rail Crossings.—Given the gauge and the angle of crossing of rails, what rule is generally adopted to obtain the radius of the curve and the rails?—R. A. J.

Dynamite.—Why does dynamite, when it explodes, penetrate farther and with greater force into a stone (or other substance) in a downward direction than gunpowder?—T. D.

Twist Drill Cutters.—Can any reader give me a method of getting the correct thickness and shape of cutter for any diameter of twist drill, straight lip? A drawing will greatly oblige.—J. M. F.

Poole's Grinding Machine for Lathes.—Required, the address of makers of this machine.

Engineers' Wages.—Would any reader kindly give me some information as to the wages at Cape Colony and Mexico for mechanical engineers?—Regular Reader of "The Mechanical World."

Rust Joints.—How can I stop leakage in a vertical joint (rust joint) in my hot-water pipes (low-pressure system) without cutting out the packing? Would any fluid cement percolate into the crevices and harden there?—B.

Makers of Builders' Ironwork.—Can any reader furnish me with addresses of firms who are makers of machinery for making builders' ironwork, such as bands and hooks, cavity irons, etc.?—Smith.

Locomotive.—Will any reader of The Mechanical World kindly give me the best way to trammel a locomotive which has too much play in the axle boxes and more on one side than the other? There are no centre marks on the crankpins.—Dubbs.

Electrical Resistance.—Can any reader give me any information relative to the resistance offered to the passage of electricity by carbon rods and platinium wire? Is there a small work published on the subject? If I had formula, I could work out myself.—Carbon.

Electric Trolley.—I am in want of a trolley to carry about 3 tons a short distance on a good road nearly level. Can I get one to be self-propelling, and what would be the best kind of motor? I shall be glad if any reader can inform me where anything of this kind can be seen—Corn Miller.

Conveying Device.—I want to remove cut straw, ⅜in. long, from chaff cutter to a room distance 60ft., round one curve, at the rate of 5 tons per hour. What size tube shall I require, and how can I do it by means of a blast fan so that the chaff does not go through the fan? Would sanitary tubes do for the purpose, underground?—Puzzled.

Facing Slide Valve Faces.—I require a hand appliance, not expensive, suitable for getting up the faces of slide valves of portable, traction, and other engines, say when the valve face is some 3in. to 5in. from the valve-chest cover face. Are there no small hand-lever appliances which can be screwed on to a stud and used for working a broken file or similar tool?—Nescience.

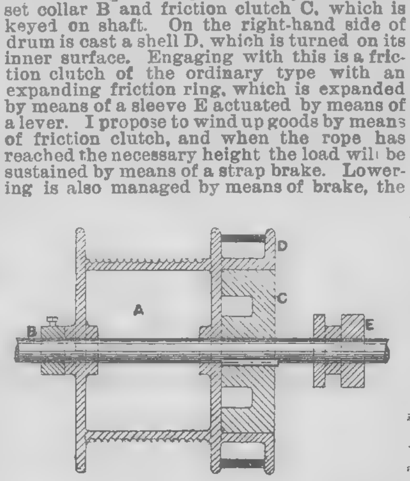
Dynamo Shaft.—I should be much obliged if the author of "The Design and Construction of Stationary Engines," or some other reader, could give me a formula (or refer me to any book where I could find it) for arriving at the size of shafts for dynamos and motors; given distance between bearings, weight of armature and pull on periphery of same in lb. Any information with respect to this would be much appreciated.—A Young Electrical Engineer.

Exhaust Steam.—Could any of your numerous readers give me any information as to how to dispose of exhaust steam from a donkey feed-pump, and say if it would be right to put the exhaust steam into the feed-water on the suction side, and what arrangement is required for this? The water is at present 80° F., and the pump has to lift it 12ft. Will the pump work satisfactorily if the exhaust steam be put into water at 80°.—Injector.

Air Compressing Staying.—(1.) How many cubic feet of air could a 1I.H.P. engine force into a chamber against a pressure in the chamber of 11lb. per inch? (2.) What kind of pump or blower would be most useful, economical, and take little room? (3.) What kind and diameter of rods 2 ft. long would be required to stay roof and floor of an iron chamber against pressure from within, each rod to withstand pressure of 60 tons?—A. C. S.

Feed-water Heaters.—Would someone kindly inform me how to calculate and give all particulars of a plain wrought-iron vertical or horizontal cylindrical feed-water heater; number of tubes, diameter, and heating surface, height and diameter of wrought-iron cylinder, and whether brass or wrought-iron tubes would be best, for an engine with 16in. cylinder by 2ft. 3in. stroke, making 70 revolutions per minute? Steam pressure, 60lb per square inch; cut-off at ⅝ stroke; size of exhaust pipe, 5in. diameter; steam pipe, 4in. diameter; exhaust steam to pass through heater tubes. How much larger would heater have to be for a pair of engines with cylinders as the one above?—Feed Water.

Hoisting Gear.—The sketch represents an arrangement for hoisting by means of a friction clutch, and consists of a winding drum A (with spiral turned groove for line rope) running loosely on a turned shaft, and kept from moving laterally on shaft by means of a set collar B and friction clutch C, which is keyed on shaft. On the right-hand side of drum is cast a shell D, which is turned on its inner surface. Engaging with this is a friction clutch of the ordinary type with an expanding friction ring, which is expanded by means of a sleeve E actuated by means of a lever. I propose to wind up goods by means of friction clutch, and when the rope has reached the necessary height the load will be sustained by means of a strap brake. Lowering is also managed by means of brake, the



clutch being disengaged. What I require is to find out the proper size of friction clutch—i.e., diameter of ring and width, also dimensions of brake wheel, and kind of brake most suitable. The data are as follow:—Tension of wire rope, 2800lb.; diameter of winding drum, 1·75ft.; velocity of drum, 10 revolutions per minute; speed of rope = circumference or 1·75×10=5·5×10=55ft. per minute; H.P. required to do the work=4·7H.P.; and allowing for, say, 70 per cent. efficiency, the actual H.P. =6·7H.P.—C. Percival.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ **Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.**

Young Beginner.—The books we named will suit you.

J. Howard.—Yes; articles on moulding are eligible.

D. D.—We can only advise you to advertise offering your services.

H. S.—(1.) 10 of copper, 10 of tin, and 80 of zinc. (2.) 9 parts of copper and 1 of tin.

S. B.—The pressure to be obtained is governed by the strength of the containing vessel.

E. O.—Plumbers' solder consists of two parts of lead and one of tin. The solder cloth may be a piece of clean canvas or felt.

Worm.—(1.) When you use a double-threaded worm you practically halve the number of teeth in the worm wheel, since each thread gears with alternate teeth. (2.) The weight of the parts.

A. Brooke.—We are obliged for your letter pointing out that Messrs. Mather and Platt were anticipated in giving the nine hours to their men—but, after all, the few hours difference in time is very insignificant.

Pitch Dark.—(1.) Harden your steel and temper to a light straw; then draw them across one pole of a permanent or an electro-magnet, making contact only in one direction. (2.) Messrs. Robert Cook and Co., Hathersage Works, Sheffield.

Young Draughtsman.—(1.) You do not give the thickness of the substance to be stamped. If it is only thin you would obtain an enormous force exerted during a very short period. (2.) The size of pipes in hydraulic work of the kind you name is not very material. It is only required to transmit pressure, and the speed of the water is very low.

T. Smaith.—Pulverise 3 parts by weight of prussiate of potash, 1 of borax, 1 of saltpetre, and ⅓ of sugar of lead, and intimately mix the whole. After heating the steel to be hardened to a red heat, take it from the fire and scatter the powder over it. The steel is then replaced in the fire, and after having been brought to the required degree of heat, cooled in cold rain water.

J. E. Clark.—(1.) "The Corliss Engine," by Uhland, the price of which is, we think, 45s. (2.) Yes; it may be had from our office. (3.) The conventional tints used in colouring mechanical drawings are:—Wrought iron, Prussian blue; cast iron, Payne's grey; steel, indigo tinged with crimson lake; copper, crimson lake; brass, gamboge; gun metal, cadmium; leather, light sepia; earth, burnt umber.

Nescience.—(1.) 50 parts of tin, 5 of antimony, and 1 of copper. (2.) We have inserted a query. (3.) 9 parts of lead, 2 of antimony, and 1 of bismuth. (4.) Unless you can remove the seat, the only way is to grind the valve and seat together somewhat in the ordinary way, by continually changing the part of the ball in contact with the seat. A piece of wood bored and split will suffice to hold the ball.

Boiling Coppers.—What is the grate area required to boil five 100-gallon coppers and one 50-gallon copper? Said coppers are steam jacketed; inside of copper, outside of wrought iron; boiler pressure 80lb., reduced to 7lb. before reaching coppers. Will be glad of rule for calculating above.—G. Haywood.——A.—Mr. Ventris, of 11, Gorton-street, Manchester, would like to communicate with Mr. G. Haywood.

Disinfectant.—Will any reader kindly tell me how to make a cheap and effective disinfectant powder?—Boilers.——A.—1oz. of the permanganate to 3 pints of water makes a solution of the same strength as Condy's fluid. I have used this for years with great satisfaction. It costs 3d. an oz., and probably could be got from the makers for 6d. a lb. If a powder be necessary, how would it do to try permanganate ground to powder and mixed with dry clay in powder or fine ashes? The fluid is quite harmless, and may be used for many various purposes.—Henry Graham.

Condensers.—Will any reader kindly inform me how to calculate the cooling surface and air-pump capacity required for an outside condenser for a steam launch? Double-cylinder simple engines; cylinders, 4½in. diameter by 5in. stroke; 200 revolutions per minute; 100lb. pressure per square inch; 8I.H.P.?—A. I. C.——A.—Seaton, in his manual, says that the condensing surface may be about half of the heating surface of the boiler, and taking the temperature of the sea water at 60° F.,

Ter. pres.,	30	lb. abs.	....	Allow.	3	sq. ft. per I.H.P.
,,	20	,,	....	,,	2·5	,,
,,	15	,,	....	,,	2·25	,,
,,	12½	,,	....	,,	2·0	,,
,,	10	,,	....	,,	1·8	,,
,,	8	,,	....	,,	1·6	,,
,,	6	,,	....	,,	1·5	,,

Assuming your cut-off to be at one-third of the stroke, this gives a terminal pressure of 38lb absolute. Allowing 3·5 sq. ft. per indicated horse-power, we get 3·5 × 8 = 25 sq. ft. The capacity of a single-acting air pump is generally from one-sixteenth to one-eighteenth of the capacity of the cylinder exhausting into the condenser.

$$\text{Capacity of cylr.} = 2 \times 4\text{·}5^2 \times \frac{\pi}{4} \times 5 = 159 \text{ cub. in.}$$

Assuming stroke of pump to be 2½in., then

$$\text{area} = \frac{159}{16 \times 2\text{·}5} = 3\text{·}96 \text{ sq. in.}$$

This gives a diameter of 2¼in.—B. S.

Pumping Plant.—Wanting to lay down a pumping plant to pump 60,000gals. of water per day of 10 hours from a shaft 240ft. deep, I should be glad if some reader would answer the following questions. (The arrangement is similar to that shown in The Mechanical World for July 15, 1892, only plunger lift instead of jack-head preferred.) (1.) Diameter and length of stroke of plunger. (2.) Size of engine required, having due regard to fuel economy, coal costing about 16s. per ton. (3.) Sizes and proportions of wheel gearing. (4.) What amount of coal per day of 10 hours should be consumed, assuming the coal to be of fair quality?—J. P.——A.—The size of the plunger lift can be found as follows:—$G = D^2 \times 0\text{·}034 \times L \times N$. G = the quantity of gallons delivered per minute. D^2 = diameter of pump in inches squared. L = length of stroke in feet. N = number of strokes per minute. In this case $G = \frac{60{,}000}{60 \times 10} = 100$. Then by the above formula, $100 = D^2 \times 0\text{·}034 \times L \times N$. Here we must assume any number for L and N. Say L = 5ft. and N = 8, $\therefore D^2 = \frac{100}{0\text{·}034 \times 5 \times 8} = 73\text{·}53$ nearly. $D = \sqrt{73\text{·}53} = 8\text{·}575$in. as the net diameter of pump. To allow for leakage we generally increase the area ¼. The area of a circle whose diameter is $8\text{·}575 = 73\text{·}53 \times 0\text{·}7854 = 57\text{·}75$sq. in., and $57\text{·}75 + \frac{57\text{·}75}{4} = 72\text{·}1875$ = area of the pump required = 9·75in. diameter of plunger. Work done by the engine per minute in pumping 100gals. from a depth of 240ft. = 100 × 10 × 240, and horse-power required

$$= \frac{100 \times 10 \times 240}{33{,}000} = 7\text{·}3, \text{ say } 7\text{·}5.$$

80 per cent. should be added to overcome friction and other contingencies $= 7\text{·}5 + \frac{7\text{·}5 \times 80}{100} =$ 13·5H.P. Now we must consider the gearing. I would use one pinion and spur wheel of 2ft. and 6ft. diameter and 1¾in. pitch; then for every turn of the large wheel the pinion will make three turns. But the large wheel must make eight revolutions for the pump to have eight strokes; therefore the engine makes 24 revolutions, or 48 strokes. Assume the steam to be of 38lb. pressure, H.P. = P L A n, therefore

$$A = \frac{\text{H.P.} \times 33{,}000}{P\,L\,n} = \frac{13\text{·}5 \times 33{,}000}{30 \times 2\text{·}5\text{ft.} \times 48} = 123\text{·}75$$

sq. in. area, or 12½in. diameter. Length of stroke, say 2½ft. = L. This engine should be a condensing one; and assuming the steam is expanded down to 5lb. pressure (terminal), and back pressure in the condenser is about 2lb., then the quantity of coal consumed per horse-power per hour, assuming that a pound of Welsh coal gives out 10,000 units of heat $= C = \frac{60 \times 33{,}000}{10{,}000 \times W} = \frac{198}{W}$, where W = the working foot-pounds per unit of heat expended. In this case it will be 107·5, $\therefore \frac{198}{107\text{·}5} = 1\text{·}84$lb. of coal per horse-power per hour. Therefore, the engine will require 1½ ton of coal per 10 hours. No allowance has been made for radiation; but the steam pipes should be covered by some non-conducting material.—David Hopkins.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

20th February, 1893.

3682 Pipe Couplings. J Symington.
3688 Self-adjusting Governor. H S Booth.
3690 Combined Ammeter and Volt Meter. W R Morris.
3691 Tool for Rounding the Ends of Screwed Studs when Fixed in Place. W Payton.
3695 Hydraulic Valves. G Heritage.
3697 Apparatus for Filtering Polluted Waters. F P Candy.
3705 Automatic Box-nailing Machinery. J Hawley.
3706 Metallic Packing for Piston Rod and Valve Spindle Glands of Steam Engines.* H D Earl.
3711 Apparatus to be fitted in Ships for use as a Gauge or Indicator of the Depth of the Ship's Immersion. T G Barron.
3712 Means for Securing Tubes in Steam Generators. J Fairbairn.
3720 "Sourdine" for Induction Coils. G Andreoli.
3721 Governor for Marine Steam Engines. T James.
3722 Gas Burners. R H Gould.
3729 Supply of Electric Current for Electric Railway and Tramway Purposes. G Kapp.
3730 Dovetailing Chisel for Mortising Machines. J E Smith.
3733 Axles for Locomotives and Railway Carriages and Vans. G C Downing. (*F Weidknecht*, France.)
3734 Secondary Battery Plates or Elements. A Hough and O March.
3743 Preparation of Carbon Electrodes for Electrolytic Operations. E H Liveing.
3744 Carbon Electrodes. E H Liveing.
3747 Process for the Production of Electrolytic Copper.* M Perreur-Lloyd.
3749 Apparatus for Dressing Tin and other Ores. J Rule.
3753 Safety Mechanism for Hoists. A J Boult. (*J des Georges*, France.)

21st February, 1893.

3757 Thermo-dynamic Motors. A C Brown.
3758 Box-nailing Machines.* W S Doig.
3759 Combined Shackle and Attachment for Metallic, Hemp, and other Ropes. E J G Boyce.
3762 Index. W Henry.
3775 Electric Lamps for Lighting Shop Windows. C Darrah.
3779 Carbon Holder for Arc Lamps. W Storr.
3781 Smoke Economiser. W Bracewell.
3785 Miners' and other Safety Lamps. J Prestwich.
3786 Miners' and other Safety Lamps. J Prestwich.
3788 Thrust Block for use in Steamships for taking the Internal Thrust of the Engines, and for Centrifugal Pumps. J Adamson.

3790 RAILWAY CHAIRS and KEYS. D and J M McIntosh.
3798 APPARATUS for the DISCHARGING and MEASURING of CHARCOAL from CHARCOAL KILNS. J Houston.
3802 SPIRAL CONVEYORS and THEIR FASTENERS. A Guild and Barry Henry and Co. Ltd.
3807 APPARATUS for CONSUMING SMOKE. T H Ackroyd and Messrs. Willoughby and Co.
3809 AUTOMATICALLY REGULATING and MAINTAINING the VELOCITY of AIR CURRENTS in VENTILATING SHAFTS. C F Kite.
3810 DRIVING-BELT FASTENER to CONNECT DRIVING BANDS for DRIVING all KINDS of MACHINERY. G Keep.
3811 SLIP VALVES for USE WITH RAILWAY BRAKES. G H Smith.
3812 OVERSEAMING MACHINES. E and R Cornely.
3815 APPARATUS for the MANUFACTURE of WATER GAS. J R Paisley.
3817 ARMATURE CORES. A W Smith.
3819 CAR BRAKE for RAILWAYS and TRAMWAYS. T A Marriott.
3823 ELECTRO-MAGNETIC MOTORS. P E Mourot.
3827 HEAT DEFLECTORS.* O Imray. (*A W Atwater* and *J F Mackie*, Canada.)
3831 TELEPHONE EXCHANGE SYSTEMS. J E Kingsbury. (*The Western Electric Company*, United States.)
3832 SHEET METAL or SOLID-LINK CHAINS. A Shedlock.
3833 ELECTRIC CONNECTIONS. E W Lloyd.
3839 COCKS or TAPS. W Gunter.
3848 MANUFACTURE of PAPER and APPARATUS THEREFOR. H H Lake. (*A Howard* and *A N Kidder*, United States.)
3852 TANKS.* W Forgie.
3853 APPARATUS for EXTRACTING GREASE and GRIT from EXHAUST STEAM.* W Webster.
3855 MACHINES for SETTING LACING HOOKS. W Kalkyard.
3862 KILNS and FURNACES.* A Stein.

22nd February, 1893.

3881 VALVES. F W Wareing.
3882 PURIFICATION of SEWAGE and IMPURE WATERS. F P Candy.
3883 DISTRIBUTION of ELECTRICAL ENERGY. W Lowrie.
3888 WOVEN BELTING. G Banham and Co. Ltd. and C K Sagar.
3890 MACHINE TOOLS EMPLOYED in the MANUFACTURE of WELDED BOILERS. E Binns.
3903 TIE for the RAILS of RAILWAYS.* A Mattijetz and others.
3904 APPARATUS for AUTOMATICALLY DISCHARGING JETS of WATER or FIRE EXTINGUISHING VAPOUR and GIVING the ALARM in CASE of FIRE. J Anderson.
3911 PLUMB LEVELS and ANALOGOUS INSTRUMENTS. J Allan.
3916 REFUSE DESTRUCTOR FURNACES. N Duncan.
3918 WOVEN DRIVING BELTS. J Taylor.
3921 PULLEYS EMPLOYED in DRIVING MACHINERY by BELTS. R, A, and J R Bickerdike.
3941 CAR COUPLING. P Willis. (*C B Martin* and *T J Brown*, United States.)
3945 GEAR CUTTING ENGINES. U Eberhardt.
3946 RAILWAY SIGNAL LAMPS.* A G Evans.
3953 FIELD MAGNETS for DYNAMO ELECTRIC MACHINES. E T Hughes. (*C F Daniels*, United States.)
3958 GOVERNING APPARATUS for INTERNAL COMBUSTION ENGINES. J Atkinson.
3962 APPARATUS for SUPPLYING AIR to MARINE BOILER FURNACES. D B Morison.

23rd February, 1893.

3966 DISTRIBUTION of ELECTRICAL ENERGY. W Lowrie.
3971 GAS ENGINES. J W Hartley and J Kerr.
3977 MOULDING FIREBARS for STEAM BOILERS. R Horsfield.
3979 TELEGRAPHIC RECEIVING INSTRUMENTS. J F Hoffgaard.
3980 TELEGRAPHIC RECEIVING INSTRUMENTS. J F Hoffgaard.
3984 FLUES for SINGLE and DOUBLE-FLUE STEAM BOILERS. S Fox.
3985 STEAM BOILERS. G W Hawksley.
3986 BORING and DRILLING MACHINES. E Robinson.
3987 BRICKS for BOILER SEATING and FLUES. W Poulton.
3988 STEAM BOILERS and FURNACES. R Gregory.
3994 STOP VALVES.* A Turnbull.
4000 EMPLOYMENT of ALUMINIUM for the CONSTRUCTION of METAL FRAMES, BRIDGES, STUDS, PRESSURE BARS, or STRINGS of PIANOFORTES. W H Francis.
4001 OXIDE of IRON. H W Hemingway.
4005 FOG-SIGNAL APPARATUS. E F Maxted and W Wells.
4022 CONVERTING HYDROCARBONS into COMBUSTIBLE GAS. F Siemens.
4023 VALVE GEAR. A J Boult. (*G Meer*, Germany.)
4024 STORAGE BATTERIES or ACCUMULATORS. W P Thompson. (*The firm of A Vogel*, Germany.)
4027 ANNEALING FURNACES for SHEET METAL and WIRE.* A J Boult. (*C Heucken*, Germany.)
4029 METALLIC SUPPORTS for the WORKINGS of MINES. E A Cresson.
4031 CAR COUPLING. E B Reid.
4036 MEANS of TAKING POWER from ELECTROMOTORS. C R Garrard and T W Blumfield.
4039 VALVES and PISTON RODS for COMPOUND ENGINES.* F C Simpson and others.
4040 TYPEWRITING TELEGRAPH INSTRUMENTS. W Langdon-Davies.
4042 SIGNALLING APPARATUS. L B Stevens.
4044 PACKING ARRANGEMENTS for PRODUCING FLUID-TIGHT JOINTS. H C Platts and T Lowther.

24th February, 1893.

4049 APPARATUS for REGULATING the FLOW of FLUIDS. G H Richmond.
4050 SHIFTING SPANNER. E J Davis.
4068 "RECEIVER" for PAPER-FOLDING MACHINES. J S, R D, and W D Cundall.
4077 ELECTRICAL MEASURING INSTRUMENTS. H C L Holden.
4083 BLAST PIPES, TUYERES, and CONNECTIONS for SMITHS' FIRES, FURNACES, ETC. W Clarke.
4085 GOVERNORS of STEAM and OTHER ENGINES. W Clarke.
4086 ELECTRICAL SWITCHES. J H Ward and M H Goldstone.
4087 TERMINALS for ELECTRICAL PURPOSES. J H Ward and M H Goldstone.
4089 STEAM PRESSURE REDUCING VALVES. J A and S Fletcher.
4091 ELECTRICAL MEASURING INSTRUMENTS. F H Nalder and others.
4096 DYNAMO-ELECTRIC GENERATORS, MOTORS, and MOTOR GENERATORS. R Kennedy.
4099 APPARATUS for EFFECTING MOTIVE POWER. J Settle.
4102 NOVEL APPLICATION of ALUMINIUM and ITS ALLOYS. P J G Rouquette.
4103 DYNAMO-ELECTRIC MACHINES. W Lowrie.
4106 MAINTAINING POSITIVE PLATES of SECONDARY VOLTAIC BATTERIES in GOOD CONDITION. L Epstein.
4108 LUBRICATORS. B Liebing.
4111 APPARATUS for ESTABLISHING TELEGRAPHIC COMMUNICATION WITH TRAINS. F W Golby. (*N J B Etienne*, France.)
4115 THERMOMETERS and OTHER GAUGES. G A Simmons.
4118 WIND-ROWING MACHINES.* G C N Bryan.
4128 REFRIGERATING or COOLING CHAMBERS. E Hesketh and A Marcet.
4134 FRICTION COUPLINGS. J Villard and J H C Wittmann.
4134 REGULATING MECHANISM for STEAM ENGINES. S A D Chaplin.
4144 ELECTRODES of ELECTRIC, GALVANIC, and OTHER BATTERIES. A W Armstrong.

25th February, 1893.

4151 BALL VALVES. G H Wall.
4162 REDUCING VALVES. A Shiels.
4163 FOG-SIGNALLING APPARATUS for RAILWAYS.* H Painter and others.
4166 POWER-FEED BAND SAWING MACHINES. J Hall.
4170 HYDRAULIC PRESSING MACHINERY. T L Miller.
4172 APPARATUS for MECHANICALLY SEPARATING the MATTER HELD in SUSPENSION in the WATER of STEAM BOILERS. J Lister.
4180 SELF-ACTING ANTI-VACUUM VALVES for LOCOMOTIVE CYLINDERS. F W Webb.
4187 STEAM GENERATORS.* D Young. (*The Rantan Boiler Company*, United States.)
4192 RAILWAY SIGNALLING APPARATUS for USE in FOGGY WEATHER. J Kimberley.
4195 FRICTION CLUTCH. J Fitzgerald.
4200 SEPARATING GASES of DIFFERENT SPECIFIC GRAVITIES. W P Thompson.
4203 SCREW DRIVERS.* C F Hill.
4209 COMPOUND GAS MOTOR. C E Tripler.
4210 GAS CONDENSER. C E Tripler.
4225 GENERATION of GAS from WATER, STEAM, ETC. W G Bedford.

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ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

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FRIDAY, MARCH 17TH, 1893.

Solid Air.

PROFESSOR DEWAR, whose experiments on liquid air have recently attracted so much attention, has now succeeded in freezing air into a clear, transparent solid. The precise nature of this solid is at present doubtful, and can be settled only by further research. It is thought that it may be a jelly of solid nitrogen containing liquid oxygen; or, on the other hand, it may be a true ice of liquid air, in which both oxygen and nitrogen exist in the solid form. The doubt arises from the fact that Professor Dewar has not been able by his utmost efforts to solidify pure oxygen, which, unlike other gases, resists the cold produced by its own evaporation under the air pump. Nitrogen, on the other hand, can be frozen with comparative ease. It has already been proved that in the evaporation of liquid air nitrogen boils off first. Consequently the liquid is continually becoming richer in that constituent which has hitherto resisted solidification. It thus becomes a question whether the cold produced is sufficiently great to solidify oxygen, or whether its mixture with nitrogen raises its freezing-point, or whether it is not really frozen at all, but merely entangled among the particles of solid nitrogen. Whatever may be the precise nature of the result, there is no doubt that it has been attained by the use of the most powerful appliances at command. These exceedingly interesting investigations may possibly materially modify our present views of the constitution of matter.

An Electric Railway Mail Service.

THE usefulness of electric railways is being increased month by month. Not only are such lines transporting passengers in the United States, but they are also approaching, to a certain extent, the functions of steam railways by carrying light freight and mail matter, and in doing this they offer keen competition in many cases with local steam lines. In the case of the conveyance of the mails, the electric service up to December last was confined to the transport of closed mails for delivery to suburban post offices. At the beginning of that month, however, an interesting departure was made at St. Louis, on the initiative of Major Harrow, the postmaster of that city. An electric railway some forty miles long runs from St. Louis in the direction of Chicago, and the experiment now taking place consists not only in the transport of closed mails, but in the collection and delivery at all points on the route of the mails from St. Louis to the end of the railway. The line is arranged on the trolley system, and a car, previously employed for the carriage of luggage and freight, was fitted up, and is now used as a railway mail car. It is carried on two four-wheel trucks, and runs at a maximum speed of 25 miles an hour. The working staff comprises two post-office employés and a driver and conductor, although no passengers are carried. The longest run is from St. Louis to a point 18 miles distant. The car makes three trips per day, and runs without inconvenience to the passenger cars. It starts from St. Louis with the suburban closed mails and the district mails, which are dropped at the several points as the car proceeds. The letter carriers are in attendance for the delivery of their collection and for the receipt of the mail for their respective localities. Any letters the carriers hand over to the mail car, and which belong to their own district, are immediately sorted and cancelled and passed over to them again for delivery. The operation of sorting, of course, is rapidly effected on the mail car. When the end of the route is reached one of the mail car employés conveys the mail to the post office to be dealt with. So quick is the service that many letters are delivered to the addresses in 20 minutes after being posted. The great utility of the system has been proved, and it is intended to extend the service.

Condition of the Shipping Trade on the Tyne.

IT is always an unpleasant duty to record the existence of a depression in trade, no matter whether the latter is a large or small one, or in what part of the country the trade is carried on. We cannot, however, ignore the fact that there is a serious depression in the shipping industry of the Tyne. During the past month there have been a few screw steamers, the majority of which were local, chartered to load in Shields Harbour and neighbouring ports; but notwithstanding this fact other vessels have arrived to fill their places at the idle buoys, and at the end of February there was an increase of two screw steamers and one sailing vessel. The idle steamers at the end of January numbered 153, and there were four sailing ships. Some of the laid-up steamers have been tied up at the buoys for about two years, and there is a very poor prospect indeed of some of them being started again for some time to come. It is stated that all the idle berths are at the present time occupied. The Northumberland Dock also contains a considerable number of laid-up ships, representing a large tonnage. It is interesting to note that among the laid-up steamers on the Tyne on the 28th of last month 9 belonged to Whitby, 31 to Newcastle, 1 to Dundee, 9 to Sunderland, 3 to Cardiff, 33 to London, 11 to South Shields, 13 to North Shields, 8 to Hartlepool, and 4 to Liverpool. The lower reaches of the harbour are crowded with laid-up steamers, including one large Quebec trader, which has been now moored at the Stanhope Buoy, South Shields, for several months. Seventeen screw steamers are lying idle in Northumberland Dock, and in Tyne Dock there are six. In respect to the disused tonnage in the Tyne various estimates have been made; but it may be safely accepted that the registered tonnage amounts to 147,500 tons. Several local steamers, which have been laid up at Jarrow Fluke for the space of about two months and upwards, have just recently proceeded to the coal spouts and loaded their cargoes of coal, and will take their departure as soon as the Baltic is navigable.

The Paddington Station.

IN our last issue a brief reference was made to the new central electric-light station of the Metropolitan Electric Supply Company. It may now be mentioned that the station itself has not been built by a contractor, as was the case with the other stations, but that the company itself designed and constructed the buildings, which comprise boiler-house with coal store fronting the canal, engine and dynamo room, and various offices. There are five Hornsby horizontal engines, each of which drives by ropes a Kapp alternator of 100 kilowatts, giving 100 ampères at 1000 volts. An interesting feature of the station is the use of electrically-welded steam piping. The station altogether is very commodious, and has the advantage of access both by road and by the adjoining canal.

Long-distance Telephony.

THE method of transmitting conversation to long distances by means of the telephone is gradually being extended, but the limit of practicability with existing instruments and lines may soon be expected to be reached. New York and Chicago were only recently placed in telephonic communication, and now Boston and Chicago have been similarly connected. The length of the main line between the two latter towns is a little over 1200 miles. It is of course formed of a metallic circuit, consisting of two hard-drawn copper wires, weighing nearly 4cwt. to the mile. This is now the most important telephone undertaking in existence. In Germany important projects are under the consideration of the Government. It is intended to establish telephonic communication between Berlin, Cassel, and Frankfort-on-the-Maine, and an extension to Cologne. When this scheme is carried out it will place the great industrial districts of Rhenish-Westphalia in telephonic connection with the German metropolis. Other projects are to put Berlin in communication with Rome *viâ* Trieste, and to institute telephonic connection between Berlin and Paris and Brussels *viâ* Cologne. Sweden, with its well-developed telephone system, is about to advance a further step by establishing a service between Stockholm and Christiania, and this will practically place the whole Scandinavian peninsula in intercommunication. At home, too, important proposals are under consideration, they being for putting London into connection with Edinburgh, Glasgow, and Dublin. Long-distance telephony is progressing; it has already proved a keen competitor of the telegraph, and will continue to be an important rival.

The Electrical Contract.

AFTER a perusal of the specification for the establishment of a central electric-light station at Liège, Belgium, and of which mention was made in this column last week, we can only conclude that the conditions imposed upon intending contractors are very severe. The concession, it will be remembered, is for 25 years, and at the end of that period the whole of the works—that is, the buildings, generating plant and accessories on the premises, feeding and distributing mains, public lamps, etc.—pass into the possession of the Administration Communale, without the latter, with the exception of for the site, paying any indemnity. This is only one instance of the onerous conditions. But even this is rendered more severe: a maximum charge must be stated for different ranges of consumption of current, and, as a matter of course, these charges must be high by reason of the manner in which the town will acquire the works, and by the comparative smallness of the town, and therefore the low demand for light. Then, again, the town may either in 1903, 1908, or in 1913, take over the whole of the works, at their then value, without waiting until the expiry of the concession in 1918. The delightful vagueness of the meaning of "then value" is important; it has agitated the minds of our tramway and electrical companies, and has even led some persons to state that it means the price of "old iron." At all events, there may be some firms who would like to investigate the matter for themselves, and who can obtain a copy of the specification or cahier des charges on applying to M. B. Boulanger, chef de la division des travaux de la Ville, Liège.

Warren's Life-saving Appliances.

THERE is at present being exhibited in the Yacht Exhibition, at the London Aquarium, by Warren's Indurated Wood Fibre Syndicate, London, a number of life-saving appliances and buoyant apparatus for use at sea, the invention of the late Captain F. P. Warren, R.N. The principal novelty in these appliances lies in the fact of their being manufactured of indurated wood fibre, which is said to possess special advantages for the purpose named. In the preparation of this material, the gummy and other foreign matters are first extracted from the timber, leaving only the fibre, which is then treated in a similar manner to rags for making paper pulp. The wood pulp is then mixed with water, placed in moulds, and the air pumped out, creating a vacuum, after which a plunger is made to act on the pulp under atmospheric pressure. By this means the water is pressed out, and, in the case of life-buoys, a deep pan-shaped article is produced which forms one-half of the buoy. These portions are then submitted to hydraulic pressure and the shape is completed, after which they are slowly dried and then saturated with linseed oil and stoved at a temperature of about 300° F. The halves are then mechanically fitted together so as to be absolutely air and water tight. By this process all kinds of life-saving appliances, similar to those in use at the present time, can be made. The great points of superiority in the Warren buoys and belts over those of ordinary manufacture are their great buoyancy, the small space they occupy in proportion to their buoyancy, and their imperviousness to wet, heat, cold, or variations of temperature or climate. Buoyancy for buoyancy, they are stated to be lighter by one-half than those of any other material at present in use. These appliances have been accepted by the Board of Trade, which has given certificates of approval, and they are now coming into use.

Metal-cutting Tools.

(*Continued from page 83.*)

Boring Tools.—Boring tools, while of almost endless variety, may be considered as merely modifications of a few general types, embracing the functions of the several kinds of lathe tools previously described. There are three distinct methods of using them, each of which has its modifications, and may be used indiscriminately in lathe, drill press or horizontal or vertical boring machine. The overhung bar is used for comparatively short work only, and is attached to the driving spindle either by bolting to the faceplate or by having a taper shank fitted to the socket of the spindle. For heavy work on large lathes they are usually made of cast iron, and provided with a good-sized flange, by which they are bolted to the faceplate. In this case the bar revolves, and the work, bolted to carriage, is fed by the regular lathe-feeding device. There are several methods of holding the cutters, which are usually placed at, or near, the end of bar. For work of large diameter, such as engine cylinders, etc., a very convenient device is to have a flange or disc on the outer end of the casting, in which is fitted a transverse slide furnished with a feed screw and means of clamping in position after adjustment, the slide, of course, being provided with some convenient method of holding the cutter or tool. The latter, for this style of rig, may be regular lathe tools, such as are used for inside turning. All varieties of work necessary for almost any conceivable purpose may be done by the device, such as finishing the bore, squaring

off and facing flanges of cylinders, recesses, internal thread cutting, etc., and even outside turning, where the character of the work requires the several operations to be completed at the one setting. As before stated, the tools used partake more of the character of turning than of boring tools.

While strictly speaking the operation of boring is specifically inside turning with a rotating tool, this distinction does not hold good exclusively, for the reason that some of the largest work is done by the use of a stationary bar in the vertical boring mill, upon which the work revolves. Whether the work or the tool revolves, however, is immaterial so far as the form and operation of cutting of the latter is concerned. A modification of the cast-iron boring arm is used for diameters too small to admit of the use of the latter. It consists of a bar of wrought iron or steel, having usually a cross foot forged on the end in the place of the flange, by which it is bolted to the face plate. The cutter is generally held in a rectangular slot cut through the bar a short distance from the end, and is secured by means of a taper key, or a set screw tapped into the end of the bar, and extending through to the slot. The adjustment is made by tapping out the cutter until the proper size of hole or depth of cut is obtained, and then setting up firmly on the key or set screw.

Where the bore does not extend entirely through so as to open at front end, it is sometimes necessary that it be bottomed—that is, the closed end must be squared up. This requires the use of an offset tool, or a bar having a dovetailed slot in the end, so that the cutter may project beyond the bar, and be capable of working on both the periphery and the end of the bore. An instance of this class of work is the hydrostatic cylinder in a wheel press, which, from its shape (being usually cast in one piece with the housing), cannot conveniently be bored in any machine on which the work is required to revolve.

For work of still smaller size, the bar used may be provided with taper shank to fit the socket of spindle. The method of holding cutters is the same as for the bar last described. Where the depth of work will admit of its being done, it is well to support the outer end of this bar by means of the dead centre, which will be very effective in preventing any springing of the bar and consequent chattering of the cutter—the result of which is apt to be a hole neither straight nor round. Also much heavier cuts and stronger feed may be used where the outer end of the bar is rigidly supported.

The next form of bar to consider is that which passes entirely through the work, and is carried by the centres in the lathe or by the spindle socket and a tail bearing or centre in the horizontal boring machine. As it is generally used for long work of small relative diameter, or for a number of bores on the same axis which require to be finished at the one setting, the bar is provided with a number of through slots for carrying the cutters in any portion of the length of bar required to suit the work. For use in the lathe this bar requires the work to be clamped to the carriage and fed in the usual way.

In the horizontal the spindle feed is used, and the bar must therefore pass through the tail bearing as it is fed to the work. This bearing is a very important feature in the use of the bar, as unless the alignment with the axis of the spindle be exact a taper hole will be the unavoidable outcome. Therefore ample means of accurate adjustment as to position become absolutely indispensable, and also a provision for taking up any lost motion between the bar and its bearing, the effect of which would be a hole both taper and out of round. This form of bar is sometimes used (though of much shorter length) in the vertical boring mill. In this case, however, the bar is usually stationary, while the tail bearing, being in the table of the machine, necessarily revolves with it, and cannot therefore be out of line with the bar if the machine be in good order, and, of course, requires no adjustment.

On both horizontal and vertical machines the tail bearing is provided with a set of hardened bushings for the different size of bars used. For the former machine they are made adjustable as to internal diameter, to enable them to fit the bar accurately. About as simple and effective a method as any for this purpose is to turn the bushing taper on the outside (the bearing by which it is carried being tapered to correspond), and cut through the entire length on one side. By means of a bolted flange or other similar device, the bushing may be forced into its bearing until it closes sufficiently to properly fit the bar, after which the accurate line adjustment may be made.—"Iron Age."

(*To be continued.*)

Mechanical and Engineering Drawing.—VIII.

By a Practical Draughtsman.

As angles cannot be *measured* without a knowledge of the parts and divisions of the circle (Fig. 15), we must, before giving further definitions of plane figures, explain these. The boundary line A B C of this figure is called its *circumference*. Any straight line drawn through D, its *centre*, and touching the circumference on both sides, is a *diameter*. Half of such a line is called a *radius*. Any portion of the circumference, such as from A to B, would be an *arc*, and a straight line joining A and B the *chord* of that arc; the space enclosed by the arc A B and its chord is called a *segment*, and that by the arc A C and the two radii A D, C D, a *sector*. One quarter of the whole figure or circle is a *quadrant*, and one half of it a *semi-circle*. For the measurement of angles, arcs, chords, etc., the circumference of every circle is supposed to be divided into 360 equal parts called *degrees*, which are indicated when speaking of them by attaching a small circle to the right of the number stated—as 30°, 60°, etc. (or 30 degrees, 60 degrees, etc.). A quadrant, therefore, contains 90 degrees, and a semi-circle 180 degrees. The size of any angle is determined by the number of degrees contained in the arc subtending the angle, described about the angular point *d*, as a centre (Fig. 18). The *complement* of the angle *a* is the number of degrees it is wanting to make it a right angle, and its *supplement* is the number of degrees contained in the angle *b*.

Circles are *concentric* when they have the same centre as in Fig. 19, and *eccentric* when their centres are different, as in Fig. 20.

A *tangent* is a straight line which touches a circle or a curve in one point, and when produced does not cut it as A B (Fig. 21).

Tangent circles and *tangent curves* are those which touch each other in one point, but do not cut as in Fig. 22.

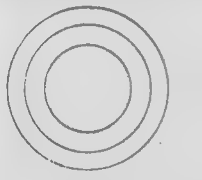


Fig. 19.

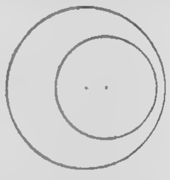


Fig. 20.

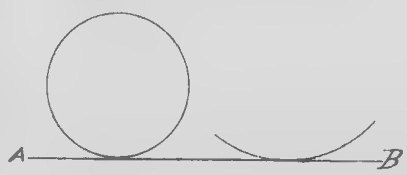


Fig. 1.

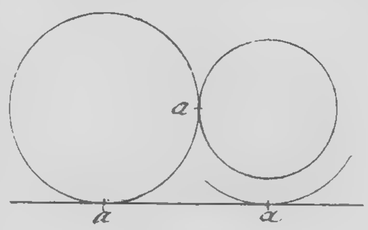


Fig. 22

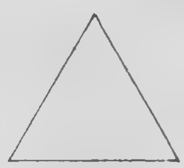


Fig. 23.

Fig. 24.

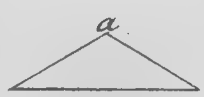


Fig. 25.

Fig. 26.

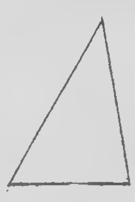


Fig. 27.

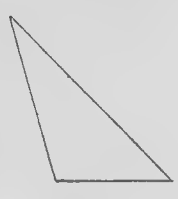


Fig. 28.

The *point of contact* is that point where a tangent touches a circle or a curve, or where two tangent curves touch, as *a* in Fig. 22.

In continuing our definitions of plane figures we take first those constructed with the least number of *straight* lines that will enclose a space, which is *three*. Such figures are called triangles or three-angled, and are named according to the disposition of their sides and quality of their angles.

An *equilateral* triangle has equal sides and equal angles, which are all acute, as in Fig. 23.

An *isosceles* triangle has two sides equal and two of its angles always acute, the third angle being acute or obtuse, dependent on the length of its third side, as Figs. 24 and 25, the latter having one obtuse angle at *a*.

A *right-angled* triangle has one of its angles a right angle, the other two being acute, as Fig. 26.

A *scalene* triangle has three unequal sides, as Fig. 27; an *obtuse-angled* triangle has one obtuse angle, as Fig. 28; and an *acute-angled* triangle has all its angles acute.

Of four-sided figures bounded by straight lines:—

A *square* has all its sides equal, and its angles right angles, as in Fig. 29. A *rectangle* has opposite sides pairs, and parallel, and its angles right angles, as Fig. 30. A *parallelogram*, or *rhomboid*, has two pairs of parallel sides, as Fig. 31. A *rhombus* has all its sides equal, two of its angles being acute, as Fig. 32. A *trapezoid* has only two sides parallel, as Fig. 33. A *trapezium* is an irregular figure of four sides, none of which are parallel, as Fig. 34.

A *regular polygon* is a figure having all its sides and angles equal. One of five sides is a *pentagon*, as Fig. 35. One of six, a *hexagon*, as Fig. 36. One of eight sides, an *octagon*, as Fig. 37. An *irregular polygon* is a figure whose sides and angles are unequal.

The *centre* of a polygon is a point that is equidistant from its sides and its angular points. A polygon is *circumscribed* when all its angular points touch a circle described about it, as in Fig. 38.

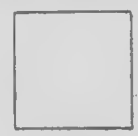
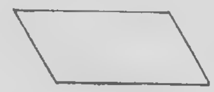


Fig. 29.

Fig. 30.



G. 31.

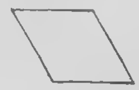
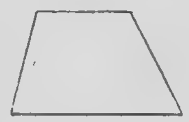


Fig. 32.



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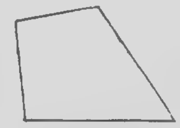


G. 34.

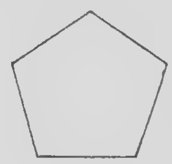


Fig. 35.

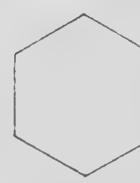


Fig. 36.

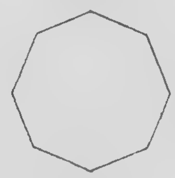


Fig. 37.

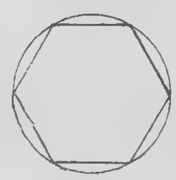


Fig. 38.

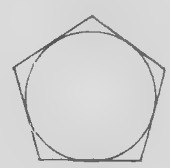


Fig. 39.

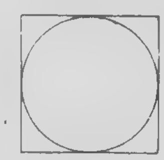


Fig. 40.

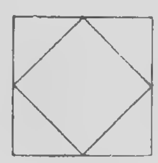


Fig. 41.

A circle is *inscribed* in a polygon when its circumference touches all the sides of the polygon, as in Fig. 39.

A right or straight-lined figure is *described about* a circle when all the sides of the figure touch the circumference of the circle, as in Fig. 40; and a straight-lined figure is *inscribed* in another such figure when the *angular* points of the inscribed figure are upon the sides of the figure in which it is inscribed, as in Fig. 41.

A straight line joining the *opposite* angular points of any four-sided figure is a *diagonal*. A square or a rectangle has its diagonals of equal length. In a rhombus, rhomboid, trapezium, and trapezoid the diagonals are unequal.

As an apprenticeship to any mechanical trade cannot be served in a factory or workshop without the apprentice, as he advances in knowledge and skill in it, being often called upon to *line out* his own work, it is necessary that he should be able to draw any of the above-described plane geometrical figures *on the material* he works in, with a steel straight-edge, a scriber, a pair of shop compasses, and a centre punch, instead of the tee and set squares, etc., of the draughtsman. With this fact in view, we shall give in the solution of each of these problems the simplest possible method of construction, it being undesirable to burden the memory of the student with the many ways of solving them to be found in text-books.

(*To be continued.*)

Manchester Association of Engineers.

On Saturday, the 11th inst., the tenth meeting of the 37th discussion session of the Manchester Association of Engineers was held at the Grand Hotel, Aytoun-street, Manchester. Mr. T. Daniels, president of the association, occupied the chair, and there was a large attendance of members. In the course of a paper on "The Relations Between Employers and Workmen in Engineering Works," Mr. C. R. Iorns said the question of the conditions of labour—in other words, the relations between employers and workmen—had become so strained and acute that some 40 years ago it crystallised itself into what was called the "Condition of England Question." Since then these relations had greatly improved, notwithstanding certain ugly facts—as, for instance, the prolonged dispute between the Lancashire cotton spinners and their workpeople, which, apart from all the loss and suffering the dispute entailed, was marked by an absence of bitterness and acrimony on both sides, and by a forbearance founded upon an enlightened intelligence, which had never been so conspicuous in a labour dispute before. This conflict, and many others in recent years, showed that the masters had come to regard their workpeople as something more than mere machines, and that the workpeople were disposed to act more like men and less like machines. A great improvement had therefore taken place between masters and men, and it was significant that to the satisfactory solution of the capital and labour problem the best thought of this and other countries had been given for many years past, and numerous experiments had been tried, some of them at great cost, with a view to hasten this solution. To enable the faculties of a man—mental and moral, as well as physical—to attain their full development, it was now contended that shorter hours of labour were necessary. An interesting experiment of what was known as "the 48 hours week" was being tried by a Manchester firm of engineers, Messrs. Mather and Platt. Whether all that was expected from this experiment would be realised was very doubtful; but, whatever the result might be, the experiment would be watched with the greatest interest by all large employers of labour, and should the expectations of those who had faith in it be approximately realised, it would give an impetus to the demand for shorter hours that it would be difficult to resist. As things now stood many of the employed seemed to think that all they had to do was to get inside the gates of the works a certain number of times per week to entitle them to draw their wages at the week end, utterly ignoring the common-sense principle that the employer was entitled to their full services during working hours. All present must be aware of the general dilatoriness displayed by the men in getting to their benches or machines after the bell had been rung. As a rule fully five minutes were lost at each starting time before work was commenced, and this entailed a serious loss to the employer. Take the case of a

firm employing 500 hands, with three starting times a day. The total time per day would be 125 hours, making a loss equal to the rental of a works employing this number of hands. Another feature was the ingenious manner in which the men in all branches "nursed" their work when they had reason to suppose that orders were scarce, and how, in the case when orders were plentiful, they seized upon the most trivial points to harass the concern. It was a matter for regret that, owing to the want of thought arising from defective or little education, the workmen were now so easily led astray by the plausible phrases of the professional agitator. To ensure industrial peace and prosperity it was essential that our workpeople should be educated to the fullest possible extent, and then they would more and more recognise how identical their interests were with those of their employer, and be more influenced by that spirit of equity and justice expressed in the motto, "A fair day's work for a fair day's wages." The closer the relationship between employers and employed could be drawn, and the more fully the interests of each could be made identical, the nearer we should be to a state of industrial peace and prosperity. A discussion followed, and before the proceedings terminated Mr. Iorns was accorded a hearty vote of thanks for his paper.

On Moduli of Sections.

[CONTRIBUTED.]

(Concluded from page 93.)

3. *The Circle.*—In order to obtain the polar moment inertia of a circular section, we must imagine the circumference of the circular section divided into n equal parts, and the points so obtained on the circumference joined by straight lines with the centre, forming n equal sectors.

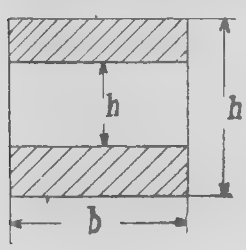


Fig. 11.

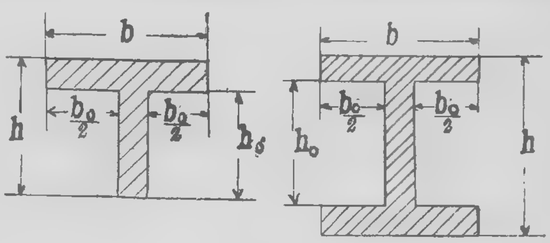


Fig. 12.

If we make the number n very large, then each sector can be regarded as a triangle. Let A B C (Fig. 8) be such a sector, then A B = b is the base of the triangle A B C, whose vertex C is in the centre of the circle. The polar moment of inertia of this triangle referred to the vertex C is, according to the above equation, $I_p = \frac{b\,h^3}{4}$, and therefore the total polar moment of the section

$$I_p = \frac{b\,h^3}{4} \times n.$$

We can write the above equation in a more convenient form, and since $(n\ b)$

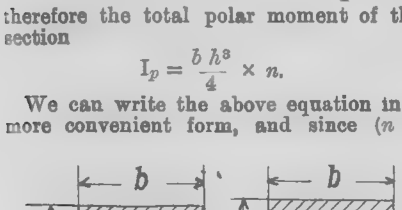


Fig. 13.

= circumference of circle, and $h = r$ = radius,

$$I_p = \frac{r^3}{4} \times 2\,\pi\,r = \frac{\pi\,r^4}{2}$$

Instead of the radius r we can write the diameter; then we have

$$I_p = \frac{\pi}{2}\left(\frac{d}{2}\right)^4 = \frac{\pi}{2}\,\frac{d^4}{16}$$

$$= \frac{\pi\,d^4}{32}$$

According to a preceding equation $I_p = I_x + I_y$, but in this circular section we can arrange a pair of rectangular axes, so that $I_x = I_y$—that is, the distances x and y are equal, hence

$$I_p = 2\,I_x$$

and

$$I_x = \frac{I_p}{2}$$

$$\therefore I_x = \frac{\pi\,d^4}{64}$$

From this equation the value of the modulus of the section will be :—

$$\frac{I_x}{e} = \frac{I_g}{e} = W$$

$$\therefore W = \frac{\pi\,d^4}{64} \div \frac{d}{2} = \frac{\pi\,d^4}{64} \times \frac{2}{d}$$

$$= \frac{\pi\,d^3}{32}$$

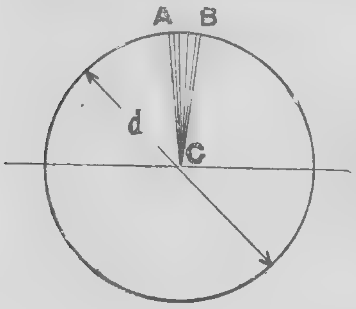


Fig. 8.

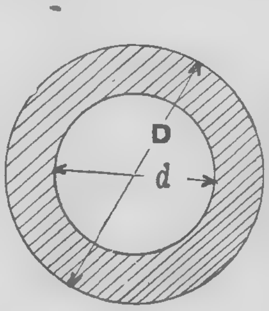


Fig. 9.

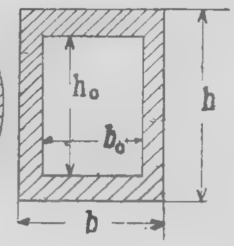


Fig. 10.

4. *Ring Section or Hollow Circle.*—Evidently the moment of inertia of a ring section is equal to the difference of the moments of two circles. Let D = diameter of the smaller circle, and D = diameter of the larger circle in Fig. 9, then

$$I_g = \frac{\pi}{64}\,D^4 - \frac{\pi}{64}\,d^4 = \frac{\pi}{64}\,(D^4 - d^4).$$

Since d is a fractional part of D, let the fraction be denoted by a, then $d = a$ D, and the equation can be written :—

$$I_g = \frac{\pi}{64}\,D^4\,(1 - a^4).$$

The modulus of the section is obtained by dividing I_g by $\frac{D}{2}$, therefore :

$$W = \frac{\pi}{32}\left(\frac{D^4 - d^4}{D}\right).$$

These are the most important moduli. All others can be deduced in the same manner by their means. Appended are the values of I_g for some other important sections, and their moduli.

5. *Hollow Rectangle or Square.*—(Fig. 10).

$$I_g = \frac{1}{12}\,(b\,h^3 - b_0\,h_0^3), \text{ and}$$

$$W = \frac{1}{6}\,\frac{(b\,h^3 - b_0\,h_0^3}{h}$$

6. *Pierced Rectangle.*—(Fig. 11).

$$I_g = \frac{1}{12}\,(b\,h^3 - b\,h_0^3)$$

$$= \frac{b}{12}(h^3 - h_0^3), \text{ and}$$

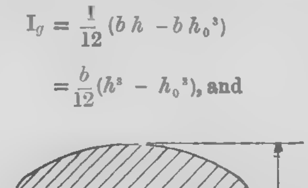


Fig. 14.

$$W = \frac{b}{6}\left(\frac{h^3 - h_0^3}{h}\right).$$

7. *Tee and Double Tee with Equal Flanges.*—(Fig. 12).

$$I_g = \frac{b\,h^3}{12} - \frac{2\,\frac{b_0}{2}\,h_0^3}{12}$$

$$= \frac{b\,h^3}{12} - \frac{b_0\,h_0^3}{12}$$

$$= \frac{1}{12}\,(b\,h^3 - b_0\,h_0^3), \text{ and}$$

$$W = \frac{1}{6}\left(\frac{b\,h^3 - b_0\,h_0^3}{h}\right)$$

8. *Angle, and Double Angle or Channel Section.*—(Fig. 13).

$$I_g = \frac{1}{12}\,(b\,h^3 - b_0\,h_0^3)$$

$$W = \frac{1}{6}\left(\frac{b\,h^3 - b_0\,h_0^3}{h}\right).$$

9. *Ellipse.*—(Fig. 14).

$$I_g = \frac{\pi}{64}\,b\,h^3 = 0{\cdot}0491\,b\,h^3$$

$$W = \frac{\pi}{32}\,b\,h^2 = 0{\cdot}0982\,b\,h^2.$$

10. *Hollow Ellipse.*—(Fig. 15).

$$I_g = \frac{\pi}{64}(b\,h^3 - b_0\,h_0^3) = 0{\cdot}0491\,(b\,h^3 - b_0\,h_0^3)$$

$$W = \frac{\pi}{32}\left(\frac{b\,h^3 - b_0\,h_0}{h}\right).$$

11. *Compound of Circle and Cross.*—(Fig. 16).

$$I_g = \frac{\pi\,d^4}{64} + \frac{1}{12}(b_1\,h_1^3 + b_0\,h_0^3)$$

$$W = \frac{\frac{\pi\,d^4}{32} + \frac{1}{6}(b_1\,h_1^3 + b_0\,h_0^3).}{H}$$

12. *Cross.*—(Fig. 17).

$$I = \frac{1}{12}\,(b\,h^3 - b_0\,h_0^3)$$

$$W = \frac{1}{6}\left(\frac{b\,h^3 - b_0\,h_0^3}{h}\right).$$

The value of I_g for all other sections can be found in the same manner as those already found, but those shown above include all those which are generally used in practice. In every case the distance e is the perpendicular distance of the extreme surface or point from the centre of gravity of each respective section.

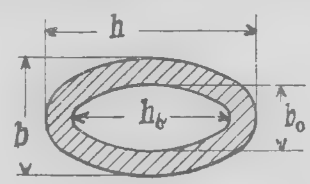


Fig. 15.

When the foregoing formulæ are used, we choose, first of all, the strongest and most suitable section for our purpose, the most suitable material and its safe working stress (for tension or compression always the least of either value is to be chosen), and the greatest bending moment. As the entire beam is to be in equilibrium, the modulus of the chosen section multiplied into the safe working stress must be equal to the greatest bending moment—that is, W k = P x.

The dimensions of a bar at any point of its length may be found as above; but it is evident that the less the distance x is, the less, also, will the dimensions of the bar be at the distance x from the point of application of the force P.

If we imagine a square-sectioned bar to be fixed rigidly in a horizontal position, and at the free end a load P to be acting perpendicularly to the axis of the bar, the dimensions obtained for the bar at distances x', x'', x'''——l from the point of application of the load will be proportional to the bending moments at these different points. We thus obtain a bar of uniform strength, and in the above case the outline of its elevation would be a parabolic curve.

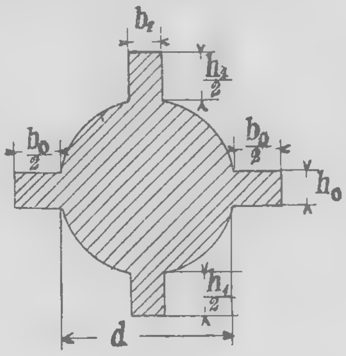


Fig. 16.

Generally speaking, the section of a bar or beam must be of constant dimensions, therefore the bar must have the greatest value of W throughout, and the correct moment will be the product of the load into its greatest perpendicular distance from the point of support.

In Fig. 18, the section XY, close to the point of support, is called "the dangerous section," for the bar will yield at this point, if it yield at all. The above equation is then generally written :—W k = P l.

As already mentioned, a bar subjected to strains due to loads has its extreme fibres either extended or compressed, whereas the middle fibres are scarcely strained at all. We might dispense with some of these without very much weakening the bar, and yet the material required would be considerably lessened. Owing to this knowledge, the well-known tee and double-tee sections were obtained.

In order to illustrate the above formulæ a couple of examples will be given here :—

Example 1.—What load will a rectangular-sectioned beam stand (wrought iron) of length 6 metres between its supports, being loaded at the centre? The sides of rectangle b and h are 100 and 150mm. respectively, and the value of k = 9kilos. per square millimetre.

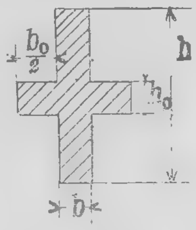


Fig. 17.

Answer.—We assume the beam to be in a horizontal position; then the leverage $= \frac{l}{4} = 1{\cdot}5$ metre = 1500mm., so that

$$W\,k = P\,\frac{l}{4}$$

$$\tfrac{1}{6}\,b\,h^2\,k \quad P\,\frac{l}{4}$$

$$\tfrac{1}{6} \times 100 \times (150)^2 \times 9 = P\ 1500$$

$$\therefore P_1 = \frac{100 \times 22{,}500 \times 9}{6{\cdot}1500} \quad 2250\text{kilos.}$$

The area of a section of the above bar is 150 × 100 = 15,000 sq. mm.

Example 2.—Let us now see what load a beam of tee section would carry under conditions similar to the beam in Example 1, its dimensions being as follows :—b 150mm., h = 200mm., b_0 = 125mm., h_0 = 160mm., and k = 9kilos., as before. Now :

$$W\,k = P\,\frac{l}{4}$$

$$\tfrac{1}{6}\left(\frac{b\,h^3 - b_0\,h_0^3}{h}\right)k = P\,\frac{l}{4}$$

$$\tfrac{1}{6}\left(\frac{150 \times 8{,}000{,}000 - 125 \times 4{,}096{,}000}{200}\right) \times 9$$

$$= P\ 1500$$

$$P_2 = \frac{150 \times 8{,}000{,}000 - 125 \times 4{,}096{,}000}{200{,}000}$$

$$\times 2250 = 3450\text{kilos. approximately.}$$

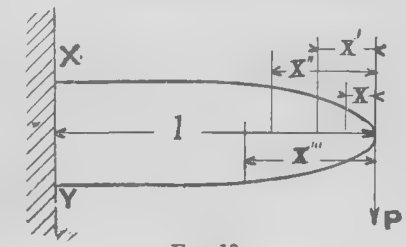


Fig. 18.

Area $= b\,h - b_0\,h_0 = 10{,}000$ sq. mm. Hence we save material and have greater strength by the following amounts :—

Saving of material $= A_1 - A_2 = 15{,}000 - 10{,}000 = 5000$ sq. mm. = $\frac{1}{3}$.

Increase of strength $= P_2 - P_1 = 3450 - 2250 = 1200$kilos. = by nearly $\frac{1}{2}$.

The advantages of the tee-section are obvious.

London Association of Foremen Engineers and Draughtsmen.

The usual monthly meeting of this association was held in the Cannon-street Hotel on Saturday, the 4th inst., when the president, Mr. W. T. Coates, occupied the chair, and there was a large attendance of members. Owing to the recent death of the vice-president, Mr. James Brown, a successor had to be elected, and Mr. W. H. Bale was unanimously elected to the vice-chair. Mr. Alexander Murdoch, draughtsman at Messrs. Humphrys, Tennant and Co., Deptford, and Mr. A. W. Hull, engineer, Edison and Swan Electric Engineering Company, Ponders End, were unanimously elected ordinary members of the association. It was announced that the anniversary dinner was fixed for Saturday, the 22nd April, and that Lord Brassey had kindly consented to preside on the occasion, and members were urged to exert themselves to make it, if possible, more successful than on previous occasions.

The President then made a statement in reference to the late Mr. Brown, giving a short sketch of his history, from which it appeared that he had been trained as a boiler maker in the Lambeth works of Messrs. Maudsley, Sons and Field; had been promoted to under foreman, and after the removal of their boiler works to East Greenwich, was made principal foreman there, which position he held at the time of his death. Mr. Coates spoke very highly of Mr. Brown as having been a first-rate workman, a competent foreman, and an agreeable and earnest co-worker in the affairs of the association. Several of the members expressed the respect and esteem in which Mr. Brown was held, and the sorrow which all felt at his having been removed at the comparatively early age of 45, and as, owing to a severe domestic affliction from which he had suffered for several years, he had been unable to make such provision for his family as he otherwise would, it was decided that an effort should be made to raise a fund for their benefit.

This was considered the best way in which members and friends could show their esteem for Mr. Brown, and the matter was left in the hands of the committee and secretary, who will be pleased to receive subscriptions from any friends for that purpose.

The Mannesmann Process of Seamless Tube Rolling.

At a general meeting of the Mason College Engineering Society, Birmingham, held on Wednesday evening, December 7, 1892, Mr. R. J. Richardson in the chair, the following paper on the "Mannesmann Process," etc., was read by Mr. W. H. Barraclough:—

In the last paper I wrote for this society I treated principally on machinery for tube making,* and referred briefly to the Mannesmann process for making seamless tubes from solid ingots. I now propose entering more fully into the mysteries of this process, so difficult to understand. If we pause for one moment at the title of this paper—"Rolling Seamless Tubes from Solid Ingots"—can we conceive anything more puzzling than to make a tube from a solid bar? But we cannot pronounce it impossible. A scientific man will be very careful how he uses that word.

It is not because we cannot see how a thing is done, that it cannot be done. No human being has sufficient knowledge to lightly use the word "impossible."

The invention all admir'd, and each, how he
To be the inventor missed, so easy it seem'd
Once found, which yet unfound most would
have thought "impossible."—*Milton.*

Let us consider the ever-increasing variety of uses to which iron can be put, and how it accommodates itself to all our wants and desires. Consider the multitude of purposes it is used for on our railways. It is used for our bridges, our ships, our stationary engines, our different kinds of machinery, our cutlery and tools, and the various small articles for use and ornament. It can be cast or wrought in any form, can be drawn out into wire of any desired strength or fineness, extended into plates or sheets, bent in every direction, and is capable of being sharpened, hardened and softened at pleasure. It is equally serviceable to the arts and sciences, to agriculture and to war. The same ore supplies the sword, the ploughshare, the scythe, the pruning hook, the needle, the pen, the graver, the spring of a watch or of a carriage, the chisel, the chain, the anchor, the compass, the cannon, and the bomb; while iron in the state of peroxide and in several chemical combinations enters largely into our medicinal preparations.

It seems to me that it would be equally true to say that pipes or tubes can be used for a like number of purposes: For the conveyance of water, gas, oil, and steam, for warming and ventilating dwellings and other buildings, and in the construction of all sorts of engines and boilers, as well as for the transmission of power by means of water or air, as pneumatic tubes for our post offices, and for the construction of all sorts of firearms from the 110-ton gun to Colt's Deringer. Tubes are used very extensively in the manufacture of bedsteads, and for many other purposes, and indeed occupy an important place in the wants of mankind.

Besides their use as tubes properly so called, they possess also the most advantageous form of columns, rods, axles, bearers, struts, etc. A given quantity of material can be formed into no shape so strong as the tubular. The advantages of a tubular construction have been fully demonstrated by the success of the tubular bridges in all parts of the world. Nature itself teaches us that where strength and lightness have to be combined the principle of hollow structure must prevail.

If we take the stem of a plant, especially of grasses, nothing with more lightness and strength would be given. Could a wheat-straw, if solid, support its head of grain with such remarkable aptitude as it does? We may go a little further into Nature and take a feather from the wing of a bird; we cannot find a better instance of the union of strength and lightness. Even the bones of a bird are hollow where great lightness is required, while the bones of animals are also hollow.

Before the beginning of this century, the use of tubes was comparatively small. In former times the conduits for water were generally made of tree trunks with a hole bored through them. Spring water was first supplied to London City from Tyburn about the middle of the 13th century, and was conveyed by leaden pipes or conduits. A further supply was obtained from Highbury in 1483. We learn from contemporary records that the Lord Mayor, aldermen, and many worshipful persons used to ride and view the conduit heads, and after dinner there they hunted a fox. (What would our modern aldermen of the city of Birmingham say to this; or the committee of the new Birmingham water supply?) Waterworks were established at London Bridge in 1512, but it was not until the year 1569 that a water supply was brought to the highest part of London.

The barrels of firearms have been used for tubes. Recently a gun-barrel was dug up in New-street, Birmingham, opposite the Grammar School, which was screwed at both ends, and had all the appearance of being used as a tube. Cast-iron pipes were first cast about the year 1780 at Coalbrookdale, and so the manufacture of tubes has gone on increasing ever since.

The consumption of tubes even in this country must be enormous, considering only one item—that in every town and village where gas and waterworks exist there must be at least two lines of such pipes lying beneath every street.

The consumption of tubes in Birmingham by the bedstead trade is enormous. Mr. Albert Phillips stated before the Railway Rates Commission that about 50,000 tons of bedsteads were made yearly in Birmingham.

It was not until the year 1808 that tubes of any length were made, when Benjamin Cook took out a patent. Since then more and more attention has been devoted to perfecting the manufacture of tubes. I need not enter into the different methods of making tubes, as I treated on this subject in my last paper on "Machines for Tube Making." Suffice it to say that it has been the aim of many inventors for the last 30 or 40 years to produce weldless or seamless steel and iron tubes, and a considerable number of processes for the production of such tubes have been devised and many patented in this and other countries, by means of some of which at the present time considerable quantities of weldless tubes of high quality are being produced.

(To be continued.)

* Mechanical World, July 4, 1891.

Shipbuilding Notes.

Messrs. William Denny and Bros., Dumbarton, launched on the 10th inst. a fast paddle steamer of 700 tons gross for the London, Woolwich and Clacton-on-Sea Steamboat Company Limited.

On the 6th inst. Messrs. J. M'Arthur and Co., shipbuilders, Paisley, launched from their yard two steel screw steamers. Compound surface-condensing engines are being fitted by Messrs. Bow, M'Lachlan and Co., Paisley.

Messrs. William Hamilton and Co., Port-Glasgow, launched on the 8th inst., from their Newark shipbuilding yard, a steel screw steamer of 190 tons register. The engines will be supplied by Messrs. David Rowan and Sons, Glasgow.

There was launched on the 8th inst., from the shipbuilding yard of Messrs. Charles Connell and Co., Scotstoun, a steel screw steamer of about 2500 tons register. The engines are being fitted by Messrs. Dunsmuir and Jackson, Govan.

Messrs. D. and W. Henderson and Co. launched on the 8th inst., from their shipbuilding yard at Meadowside, Partick, a steel screw steamer. Her principal dimensions are:—Length, 245ft.; breadth, 34ft.; depth from main deck, 16ft.

Messrs. Harland and Wolff, Belfast, launched on the 8th inst. the screw steamer "Orcana." This vessel, built for the Pacific Steam Navigation Company, has a gross tonnage of 4720 tons. The triple-expansion engines, which are of 3000I.H.P., have been constructed by the builders.

The Training of Young Marine Engineers.

At the conclusion of the paper which recently appeared in these columns under the above heading, the Chairman invited discussion. He said he was sure they had all listened with great pleasure and interest to Mr. Sage's contribution, which had given them a great deal of food for contemplation and reflection.

Mr. A. D. Patterson, whose remarks were read by the chairman, wrote:—"I am in favour of the third-class certificate, which I would suggest should be granted, particularly on practical experience. No vessel six hours out from port should have an engineer in charge of machinery without a certificate, irrespective of the size of the engines. The candidate for a third-class certificate should have at least served five years in a factory where engines are made and repaired, two or three years as fitter, one or two years as turner, and one year as pattern-maker, draughtsman, blacksmith, or boilermaker, as the circumstances of his case permitted. During this period he ought to have passed under, say, the Science and Art Department, in the following subjects:—Elementary steam, machine construction and drawing, plane and solid geometry, mathematics, chemistry, and applied mechanics; a second-class pass to be the minimum. These subjects a lad coming from the Board Schools should not now find it hard to get through, provided the standard is no higher than at present. His twelvemonths' training at sea should enable him to receive a certificate from his chief engineer, who should be held responsible to the Board of Trade for the veracity of the testimonial to be endorsed on it. This testimonial should show the candidate's practical knowledge in the application of tools, tackles, etc., combustion of coal and its various qualities and characteristics; also the various modes of stoking, cleaning of fires, clearing of choked tubes, stopping of same, etc.; his ability to solder, caulk boiler seams, rolling of tubes with expander, renewal of rivets, making of the various joints, cleanliness of boilers, and the methods employed, etc., in all details, cleanliness of bilges, and his ideas of painting, etc., for preservation purposes. He should also know something about discipline, as to his relationship with the captain of the vessel, the chief engineer and subordinate engineers; also his position relatively to the firemen and sailors. He ought also to be able to produce satisfactory evidence of his fitness to overcome sea-sickness to such a degree that there would be at no time an utter incapacity for duty owing to this cause. There is great danger at the present time that our young engineers are building too much on theory, and forgetting that it is expected from the chief engineer downwards that they will all be able to off coats, handle the hammer and chisel proficiently, strip and wrestle with the bilge water, enter the combustion chambers, expand and caulk, and many a time, in our smaller vessels, handle the shovel, rake, and slice, and often trim their own coal. But, alas! how few now, especially in some of the large mail steamers, know anything of this? I am not one to disparage the higher theory, but certainly would do so if the practical parts in any degree were not mastered."

Mr. J. Hawthorn, after expressing his great interest in the subject, said he would fully support most of the points referred to in the paper, more especially those relating to shop service or apprenticeship. He had a scheme in his own mind, and with the permission of the meeting he would explain its principal features. Firstly, he proposed that the number of the certificates should be three, and should be called the first, second, and third certificates. The first certificate obtained should be the third, and the qualifications for such should be that the candidate was 21 years of age on the birthday next before presenting himself for examination, and that he should produce satisfactory testimonials that he had served for six years on the making and repairing and handling of steam engines. If only three years had been served in the works, then the other three years should be served at sea. If four years had been served in the works, then the other two should be served at sea. If five years had been served in the works, one year of which should have been served on some shore staff or in works where marine engines only were made, then one year at sea might be accepted, with the other five years so served, but in every case the candidate should produce testimonials for six years. This he would insist upon. During these six years of apprenticeship the young engineer should endeavour to acquire by diligent study the rudimentary knowledge of mathematics, including vulgar and decimal fractions, square and cube root, elementary physics, and theoretical and applied mechanics, sufficiently to enable him to thoroughly comprehend the principles upon which the machine worked. He should also know sufficient of natural philosophy, so that he could trace the conversion of the heat energy of the coal into mechanical work. He (Mr. Hawthorn) would also insist upon the employer distinctly stating upon what work the candidate was employed during his shop service. These apprentices at sea completing their time should be called assistant engineers, and should not have charge of a watch, but should take the place of those assistants now in most cases recruited from the stokehold, greasers, etc.; and, if it were possible, he would say that when a boy was apprenticed to a marine engineer it should be considered the right thing for his employer to appoint him to some of the ships turned out by the firm in which he was apprenticed, so that his time would still be under the firm he was originally articled to. As to the examination for the first, or, as they would call it, third engineer's certificate, upon presenting himself for examination, his age and testimonials being found in every way satisfactory before his papers were accepted, the candidate should be put through a verbal examination—say in the presence of two or three properly-constituted examiners. The examiner putting the questions should have no voice in saying whether the candidate passed or failed. Having satisfied the examiners as to his fitness in the verbal examination, he should be sent to some marine engineering works appointed by the authorities; and here, in the presence of the engine, he should be asked the names of the different parts, also their duties relatively to the machine as a whole. It would be better if he could go on board some ship other than his own, and be asked to trace some of the principal pipes, etc., naming them and their duties. He should also be examined as to position of quick motion when ahead and astern, water-gauge reading, parts of boiler, etc. Should he satisfactorily pass this part of his examination, which should be looked upon as the most important, he should then be put through the scholastic part, and this should, in the speaker's opinion, consist of questions as now given for the second-class examinations, with a few additions. Having passed all three tests, the candidate should be allowed to take charge of a watch, and should be rated on the articles as third engineer or fourth engineer. After having served two years in this capacity, and having obtained a step of promotion, in the meantime he should be eligible to sit for a second certificate; but no man should be allowed to sit and obtain a higher grade certificate than the one he held if he did not obtain a step of promotion in the meantime. The examination for the second certificate should be intermediate between the second and chief's as now made, but should include sketching from some actual piece of machinery, the particulars of which were known to the examiners, and not from memory, and he should be allowed only a 2ft. rule and a pair of outside and inside calipers. Mr. Hawthorn considered that if a sea-going engineer could take out of his pocket a piece of chalk and give a pattern-maker or a draughtsman his ideas, say on a bulkhead, he had all the drawing necessary. He should be allowed to occupy either the position of second or third of any steamer with this certificate. With two years at sea with this certificate, during one year of which he must have been second, and responsible for the working of the engine-room staff, he should be allowed to sit for his chief, or first certificate, and here the examination should be, say, 50 per cent. theoretical and 50 per cent. practical. The theoretical examination should be a little more searching than at present, and should include questions on mechanical science, square and cube root, algebra up to and including quadratics, and a fair working drawing to some data, say to suit a ship of certain tonnage or engines of certain horse-power. He should also have an elementary knowledge of the principles of ship construction, which should include the principles of framing bulkheads (how such could be stiffened if necessary) and the different strains that affected a ship due to hogging or sagging, and how such straining action should or should not affect the running of his engines and shafting. Further, he should be able to calculate the difference in the draught of ship due to burning out his bunkers, and what effect such difference of draught had upon his engine's performances. His practical examination should consist of questions in methods of removing shafts, cylinders, and taking out old

engines, putting in new, so that at any time he could be called upon to superintend the same. With regard to the extra chief certificate, in the first place, he (Mr. Hawthorn) would alter the name, and make it some degree of marine engineering, which should carry with it some status. At present it had none, but it should be the qualification for all higher positions in the marine engineering profession. There was one other matter which it seemed to him should be taken up by the institute, and that was the subject of the Royal Naval Reserve. Since the engineers who joined the R.N.R. received no retaining fee, he would suggest that all engineers who joined the Naval Reserve, and had passed a preliminary examination, should be allowed to go through a course of training at the Royal Naval College, and there associate with and receive the same instructions as Royal Naval Engineers.

Mr. Anderson said he could not agree with Mr. Hawthorn on one point. He (the speaker) would not allow any engineer to go to sea before he had served five years. He was in favour of five years' shop time at the least. Then, after he had put in a year at sea, the young engineer ought to know a little, and the longer he went to sea the more he would learn. He (Mr. Anderson) would not, under any circumstances, give certificates for less than was required at the present time. When he got his certificate he had to put in a great deal more than was now requisite. He had to put in 12 months as second engineer before he could go up for a chief's certificate, and he thought that was quite right; but a man who was serving as third engineer could now go up for a chief's ticket.

Mr. J. Wing differed altogether from much that had fallen from Mr. Hawthorn, and asked where were the men going to sea who could erect an engine? They might cram a man with figures and theory, but what about his practical skill as a workman? At sea he (Mr. Wing) preferred a good workman to a good scholar. Where were they likely to find a man able to do all that was set forth by Mr. Patterson? It was impossible. They would have to cast a man for the purpose.

The Chairman said he quite agreed with Mr. Hawthorn that examinations alone were no criterion of excellence, and he related his own experiences in support of his contention that examinations did not always reveal the best men in the subjects of such examinations. Mr. Hawthorn had uttered a great many truths in his remarks that evening, and the view was very generally held all over the country that there was great need for improvement in the method in which Board of Trade examinations were at present conducted. He most strongly deprecated anything that was calculated to encourage young men in the idea that education was only a means to an end, and he was therefore entirely opposed to class education. They ought not to educate themselves merely for what education would bring them, and he could testify from actual experience to the pleasures that were derived in after life from the studies of youth. Class education was in many cases very narrowing in its results, and he would certainly discourage the laying down of arbitrary rules and subjects for the guidance of those who might be anxious to begin early to train their boys for engineers. He well remembered the remarks made by fellow-scholars, embodying ideas, shared probably by himself to a certain extent, to the effect that for certain walks in life certain studies were useless. Thus one intended for a farmer scorned classics, another intended for the Church despised botany, and so on. Although taught early to look forward to marine engineering as the goal of his ambition, it was also impressed upon him that the attainment of knowledge of any subject one had an aptitude for was certain to be useful, if not in strict relation to one's business in its narrow sense, at least in connection with personal and social life. There were many studies which, apart from their direct bearing on the intended line of life of a lad, might be of very great service to him in many ways, and it should be borne in mind to encourage lads to look upon knowledge as a thing to be desired for its own sake rather than for what it might bring in pounds, shillings, and pence. The former view broadened the character; the latter narrowed it. In making these remarks he was aware that he showed his want of appreciation of the purely utilitarian doctrine, but he admired the broad rather than the narrow view of life, and held that the man who aimed only at making himself right in his own corner, and acted accordingly, had missed altogether the true business of life.

Mr. Nicoll strongly advised young engineers to serve seven years instead of five, and this view was supported by Mr. Brett.

Mr. J. H. Thomson and others also spoke on the subject, and in the result the discussion was adjourned.

Mr. Sage was accorded a hearty vote of thanks for his paper, and a similar compliment to the Chairman for presiding concluded the proceedings.

Compound Expansion Engines.

THAT there is not only a gain, but a very conceivable gain, in economy of fuel consumption by the use of the compound-expansion principle has been too clearly demonstrated by modern practice to admit of a continuance of the scepticism which opposed it at its advent. Compound engines are to-day almost universally employed for the development of large powers, and the objectors are silenced as to the general principle, although there are legitimate grounds for doubting the wisdom of carrying it to such extreme limits as has been done in numerous instances. But while the fact of its economy is now accepted, there is still a wide discrepancy of opinion as to the real cause to which it may be attributed. Numerous theories are offered in explanation, of which some are radically opposed; and although some of them would seem to be correct logical deductions from known facts, yet the difficulty remains that they do not fully account, even on the purely theoretical basis, for the results obtained in actual practice. That there is such a cause or causes, however, is obvious from the fact that we have proof of the effect.

The present wide application of the multi-cylinder expansion principle to almost all classes of engines, large and small, condensing and non-condensing, gives an increased importance to the subject, as there is no doubt that much of the possible economy is sacrificed by reason of insufficient knowledge of the requirements on the part of the designers in proportioning and arranging the essential parts. While to a certain extent the practice which has given good results may be considered a safe guide to further application, there can be no doubt that a complete understanding of the fundamental principles involved must be essential to enable the full possible development of expansion economy.

Formerly the strongest argument against its possibility was the proposition that the same effect could be produced from a given steam consumption by means of a single-cylinder engine in which the expansion was carried to the same degree as that in the two-cylinder compound engine, and that the complication of the second cylinder, with its valves and valve motion and crank and connections, must therefore result in a loss instead of gain in economy. If we eliminate from the problem all extraneous conditions, and consider only the physical effect of the given volume of steam in the two methods of expansion, this may easily be shown to be correct, and it will be of service in the analytical investigation of the subject, by showing where not to look for the causes known to exist, as well as to suggest the direction of further research.

Let us suppose, for example, the case of a compound (two-cylinder) engine, calculated upon a given initial pressure and size of high-pressure cylinder. Let us compare the theoretical efficiency with that of an equivalent single-cylinder engine—equivalent, that is, in the volume of steam and rate of expansion. We may assume a steam pressure of 110lb. (or, calling atmospheric pressure 15lb., say 125lb. above perfect vacuum), and a terminal pressure of 5lb. Let the area of the high-pressure piston be 100 sq. in. and the length of stroke 2ft. :—

P = initial steam pressure above vacuum.
P′ = high-pressure terminal or low-pressure initial.
R = ratio of expansion for each cylinder, also ratio of high and low-pressure area.
T = low-pressure terminal above vacuum.
M = mean high pressure of steam per square inch.
M′ = mean low pressure of steam per square inch.
H = hyperbolic logarithm of R.
A = area of high-pressure piston.
A′ = area of low-pressure piston.
C = mean pressure in single-cylinder engine of same area and rate of expansion.

We find first the value of R by the formula

$$R = \sqrt{\frac{P}{T}} = \sqrt{\frac{125}{5}} = 5.$$

By table we find the hyperbolic logarithm of 5 to be 1·60944. Then by the ordinary formula—

$$C = P\,\frac{1 + H}{R} = 125 \times \frac{1 + 1{\cdot}60944}{5} = 65{\cdot}236\text{lb.}$$

This, however, will not be the value of M, for the reason that there is at all times the same pressure acting against the advance of the high-pressure piston as that which is driving the low-pressure piston; or, in other words, the mean effective pressure per square inch on the latter is the mean back pressure on the former, and this amount must be deducted from C to determine the value of M. The formula will then be :—

$$M = \left(P\,\frac{1 + H}{5}\right) - M'.$$

We must therefore first ascertain the value of M′. It is readily seen that as the area of high-pressure piston, being subjected to the same pressure, must also resist the advance of the low-pressure piston, therefore the amount of such resistance must be deducted from the mean pressure per square inch on the latter to give the effective pressure. As the ratio of areas of the two cylinders is 5, the deduction may be in the form of a percentage, dependent on the value of R. In the present instance it will be $\frac{1}{5}$ = 20 per cent. Or the formula for the value of M′ may be :—

$$M' = \left(P'\,\frac{1 + H}{R}\right) \times \left(1 - \frac{1}{R}\right) =$$

$$\left(25 \times \frac{1 + 1{\cdot}60944}{5}\right) \times \left(1 - \frac{1}{5} = 0{\cdot}8\right) =$$

10·438lb. Then $M = \left(P\,\frac{1 + H}{R}\right.$ – M′ will be $\left(125 \times \frac{1 + 1{\cdot}60944}{5}\right) - 10{\cdot}438 =$ 54·798. The respective areas will be A = 100 sq. in., and A′ = A × R = 100 × 5 = 500 sq. in. We find, then, that the total pressure driving the crank will be (A × M) + (A′ × M′) = 100 × 54·798 = 5479·8lb., and 500 × 10.438 = 5219, and 5479·8 + 5219·0 = 10,698·8lb., which × stroke = 2ft. = 21,398ft.-lb.

Let us now see what will be the power of the single-cylinder engine. The area, as given for the high-pressure compound, must be 100 sq. in. The mean pressure we have in the value of C = 65·236lb. for the equivalent ratio of expansion of one cylinder only; but in this case we must consider the ultimate expansion of both cylinders, and $\frac{P}{T} = \frac{125}{5} = 25$, or R^2, as the ratio for single cylinder. The hyperbolic logarithm of 25 being 3·2189, our formula (using the values previously given) becomes for mean pressure $P\,\frac{1 + H}{R^2} =$ $125 \times \frac{1 + 3{\cdot}2189}{125} = 21{\cdot}095$; which × 105 sq. in. in area = 2109·5lb. Now, as the point of cut-off in the first cylinder was one-fifth of 2ft., or 0·4ft., it will, of course, be the same in the single cylinder, and the length of the stroke of the latter will be 0·4 × the number of expansions, or 25 × 0·4 = 10ft. Then 2109·5lb. × 10ft. = 21,095ft.-lb., or practically the same as for the compound engine.

If for the above formulæ for high and low mean pressures we substitute the following, as given by an eminent authority, the discrepancy will be so small that it may be accounted for by the neglect to carry out the decimals in logarithms, etc., to a greater number of places. For mean low pressure $M' = P'\,\frac{H}{R-1} = 25 \times \frac{1{\cdot}60944}{5-1}$ = 10·06lb.; and for mean high pressure $M = \left(\frac{1+H}{R}\right) - \left(P'\,\frac{H}{R-1}\right) = 65{\cdot}236 -$ 10·06 = 55·176. Then (10·66 + 500) + (55·176 × 100) = 10,547·6, which × 2ft. stroke = 21,095·2ft.-lb.

The foregoing calculations are based upon Mariotte's law, that "the volume of any gas varies in the inverse ratio of the pressure—the temperature remaining constant." Also, the purely mechanical element of cylinder clearance has been neglected, though, as is readily apparent, it is of very considerable importance in the comparison, and acts against the economy of the compound system. For instance, if the clearance in the single cylinder were not excessive, it would be equal to, say, 5 per cent. of the volume of cylinder for a stroke of 2ft., or 1 per cent. for the 10ft. The steam effect lost by clearance would then be (100 × 120) ÷ 100 = 120 cub. in. at the terminal pressure of 5lb., while the loss by the compound engine would be (100 × 24) ÷ 20 = 120 cub. in. at 25lb. for small cylinder, and (500 × 24) ÷ 20 = 600 cub. in. at 5lb. for large cylinder. Of course the steam in high-pressure clearance space is not actually lost, being subsequently utilised in the low-pressure cylinder. The fact certainly will, says the "Iron Age," not assist in locating the source of economy of the latter engine.

(To be continued.)

The Junior Engineering Society, New Swindon.

THIS society held a successful meeting in the Lecture Hall of the Mechanics' Institute on Friday, March 10, presided over by Mr. A. E. Leader. Mr. F. W. Spooner, in the course of an able and interesting paper on "Appliances for the Prevention of Smoke," stated the duties and requirements of such appliances necessary to ensure efficiency. He then proceeded, with the aid of some admirable sketches, to describe and explain a number of modern devices and arrangements for smoke prevention, chief among which were the steam jet, mechanical stokers, hollow-walled furnaces, fire-brick arches, downward-draught furnaces, etc., and in conclusion drew attention to the compulsory use of some such appliances on locomotives on American railway systems. A very interesting description of an erection for smoke consumption in a smoke-stricken district in South Wales, with a statement as to profits derived from by-products of it, was given by Mr. Stephens in the animated discussion which followed, in which Messrs. Bird, Davison, Doming, and Longland took part.

Trade Notes.

The Hadfield's Steel Foundry Company Limited, Sheffield, have declared a dividend of $7\frac{1}{2}$ per cent.

Messrs. Stone Brothers, Smethwick, have taken the Vulcan Works, West Bromwich, and will shortly transfer their business to that place.

Messrs. P. and W. Maclellan, Glasgow, have contracted to supply and erect an additional turntable at the General Terminus Quay, Glasgow.

The East Ferry-road Engineering Works Company, London, have secured an order for a 160-ton weighing machine for the large crane at Finnieston.

Messrs. W. Gregar and Son, of Stratford London, have received the contract for the erection of iron buildings for the Guardians of West Ham Union.

Messrs. Robert M'Alpine and Sons, Glasgow, have secured the order for the supply of new purifiers and meters for the Dawsholm Gasworks.

The directors of Messrs. P. and W. Maclellan Limited recommend a dividend for the half-year ended 31st December last at the rate of 6 per cent. per annum.

The directors of Messrs. William Jessop and Sons have decided to recommend to the shareholders a dividend of 6 per cent. on the paid-up capital for the year ended December 31, 1892.

The directors of Messrs. A. and J. Stewart and Clydesdale Limited recommend dividends for the half-year ended December 31 at the rate of 6 per cent on the preference and 9 per cent. per annum on the ordinary shares.

The Naval Construction and Armaments Company, Barrow, have received orders from Messrs. Cayzen, Irvine and Co. to convert the engines of two of their steamers to the triple-expansion type, and also to fit them with new boilers.

The directors of Messrs. Sharp, Stewart, and Co. Limited, Atlas Works, Glasgow, recommend in their report the payment of dividends for 1892 of 6 per cent. per annum on the preference shares and $7\frac{1}{2}$ per cent., free of income tax, on the ordinary shares.

The Siemens and Halske Company, of Chicago, have contracted to supply a very large electric plant for the Auditorium Building in Chicago. The power station will supply current for 25,000 incandescent and 200 arc lamps, as well as operating the elevators.

Having regard to the enormous circulation of THE MECHANICAL WORLD, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if MECHANICAL WORLD readers will kindly bear this in mind as occasion arises.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 85, Strand, London, or New Bridge-street, Manchester.

Sugar-making Machinery.

XXIX.

Fig. 69 shows an automatic steam regulator of American origin, in which the pressure of steam in a pair of cylinders acting through levers exerts a constant

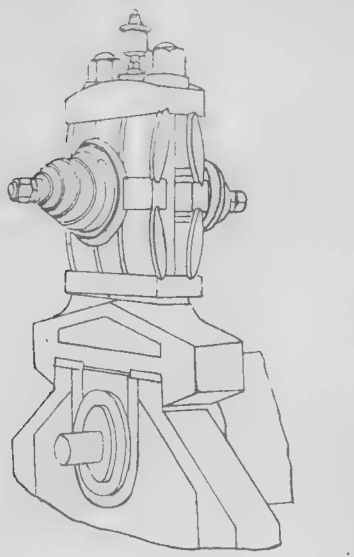


Fig. 69

effort on the top roller cap bolts, and so holds it down on the two side rollers with a load depending on the pressure of the steam, size of cylinders used, and the multiplying power of the intervening levers. It is the invention of Messrs. Malhiat and Lejewnés. The writer has no knowledge of its merits, and it is here given for what it is worth.

Fig. 70 shows a very simple and neat arrangement for giving a constant pressure to the top roller of an ordinary three-roll cane mill. The range of movement required in even the largest mills being very small, this attachment would seem to answer all requirements. This toggle gear is patented by Messrs. Mirrlees, Watson and Co., of Glasgow. It will be seen that the appliance consists of two pairs of toggle levers acted on by powerful spiral springs, such as are used for railway rolling-stock buffers. The levers press upwards

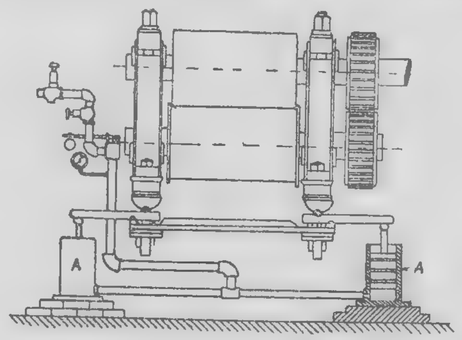


Fig. 70.

against the cap of the top roller journal. These are formed with blunt knife edges working on V grooves, and are said in practice to work with an almost inappreciable amount of friction. An important feature of this arrangement is the compensating action of the toggle levers, in consequence of which the springs, when under their least tension and exerting their minimum thrust, act at the maximum advantage, and *vice versâ*. It is only necessary to select a suitable spring to obtain a nearly uniform load on the journal through the whole range of its movement. If made perfectly uniform the result would equal that obtained by means of hydraulic cylinders.

One of the best-known automatic contrivances applied to sugar mills is a hydraulic attachment invented by Messrs. Duncan Stewart and Co. Limited, London-road Ironworks, Glasgow. The caps of the side rolls are replaced by steel hydraulic cylinders, which are fitted with rams of a size sufficient to give the requisite pressure. These rams are generally cased with brass to withstand corrosion, and steel stops are provided to prevent abrasion of the rolls when the mill is running empty. The pressure in the cylinders is derived from an accumulator loaded with cast-iron weights to give a working pressure varying from 1 to 2 tons per square inch, the apparatus being tested generally to $2\frac{1}{4}$ tons per square inch. The loss from leakage, etc., is made up by means of a small hand pump provided for the purpose. The load on the journals recommended by the makers* is 3 tons per lineal inch of the rollers, length. Taking a mill having rollers 32in. diameter by 72in. long, the total load would equal $72 \times 3 = 216$ tons $=$ 108 tons on each journal. The journals for this size of mill will be about 14in. diameter by 17in. long = 476sq. in. of diametrical section for the two bearings. The load on the bearings with this loading will be $\frac{2240 \times 216}{476} = 1016$lb. If the pressure allowed be 2 tons per square inch in the accumulator, the rams of the hydraulic cylinders would require to be $\frac{216}{2 \times 2} = 54$sq. in., or say $8\frac{1}{4}$in. diameter.

Fig. 71 shows one arrangement of mill and hydraulic attachment, which indicates the general form of such appliances. In this case the hydraulic attachment is applied to the megass roll only. It is suitable for a mill having rollers 32in. diameter by 60in. long. The accumulator ram is 4in. diameter, having a stroke of 4ft. To give a pressure of 2 tons per square inch on the rams the load on the accumulator requires to be $2 \times 12{\cdot}56 = 25{\cdot}12$ tons.

The framing of the accumulator in this case is composed of angle and flat bars, the top portion having a number of holes drilled, through which a bar can be passed to suspend any number of the weights should it be desired to increase the pressure in the accumulator.

Fig. 72 shows another style of accumulator used in connection with sugar mills, in which the cast-iron weights are threaded over the body of the cylinder, and carried by an enlarged head on the same at the bottom. The cylinder moves up and down with the weights, the ram being stationary, the top of the cylinder having a rod attached which passes through a bridge piece at the top supported on two cast-iron columns, and which serves as a guide to the cylinder.

The following are among the advantages claimed for this attachment:—A higher extraction duty, the power of maintaining the percentage of juice constant, freedom from breakdowns, less supervision to ensure regular feeding, whilst the liability to breakage from overfeeding or the accidental introduction of foreign substances is reduced to a minimum.

(*To be continued.*)

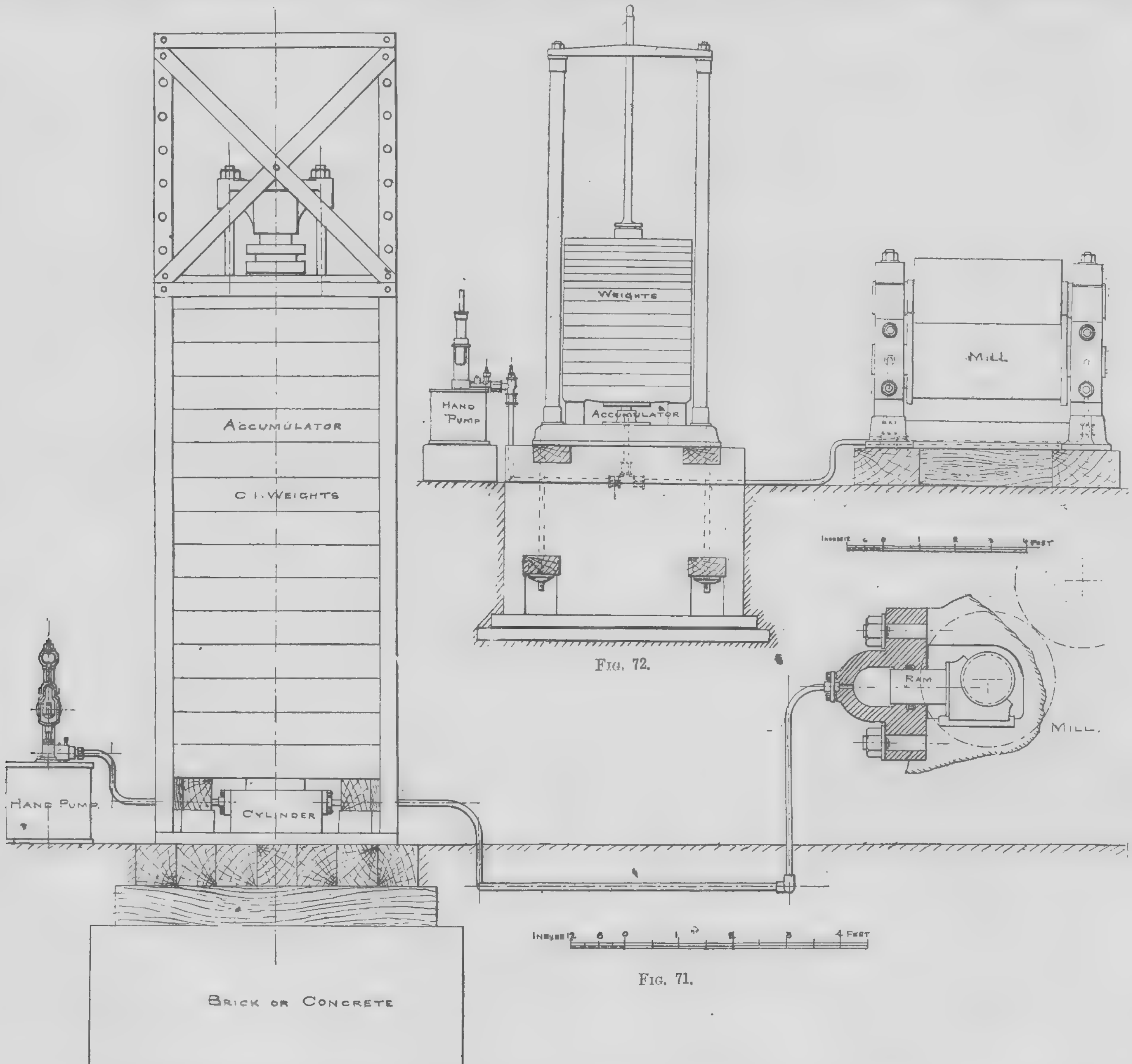


Fig. 72.

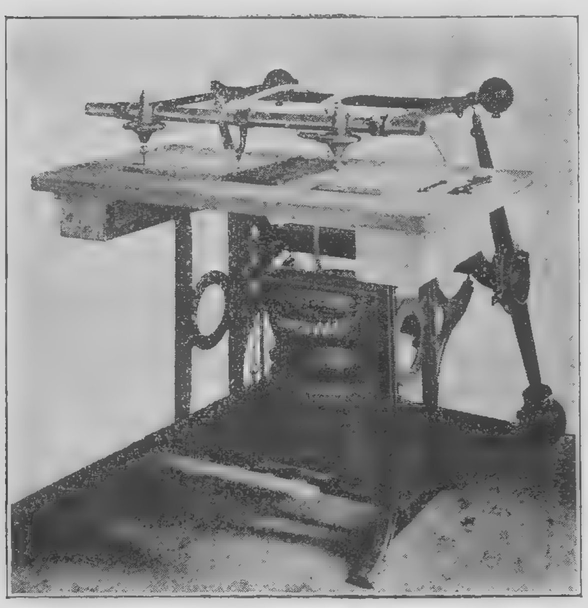
Fig. 71.

*Vide "Sugar Cane," December, 1886.

Pneumatic Wood-carving Machine.

In the accompanying engraving is shown a new wood-carving machine which is now on view at the Building Exhibition at the Agricultural Hall, London, N. As will be seen from the illustration, the machine consists of a table or bench supported upon light iron frames. These frames are carried at the back into two bracket-like projections, on which is carried a system of swinging arms and levers, so arranged as to give a universal parallel motion to the upper frame. The latter is constructed of light, solid-drawn steel tubes, rigidly put together, carrying on the front tube or bar a carving tool and motor and a tracer or dummy. The moving parts are so counterbalanced that when the tracer is held in the fingers, as in the case of an ordinary pencil, it can be moved over the table in any direction and both up and down with perfect freedom and ease. The parallel gear is arranged so that the tool or cutter is compelled to move through the same distance as the tracer, and to always maintain the same relative position to it, so that whatever figure the point of the dummy describes, the point of the tool always describes an exactly similar shape. The motor for driving the tool is very simple, consisting of a spindle running in ball bearings, the lower end carrying an ordinary drill chuck for holding the tool. Just above this is mounted a disc provided with vanes similar to those of a centrifugal pump, and which revolve inside a case. Into this case the air is led through a nozzle, and, striking the vanes, causes the spindle to revolve at a high speed. The reservoir of the bellows is loaded down with springs, so that the pressure upon it can be varied according to the quantity of air present. A flexible rubber hose leads from the bellows to the motor, so as to allow the latter to be moved about with perfect freedom. The motor is made with such accuracy and is so nicely balanced that even at the highest speed there is no apparent vibration, and there is practically no resistance to overcome in moving the tracer over the work, except that of the wood to be cut.

The original carving or pattern, which may be either in wood or metal, is clamped down to the table, whilst near it is fixed a piece of wood of the size necessary for the reproduction of the pattern. The tracer is then moved slowly by hand over the surface of the pattern, whilst the cutter removes everything which comes in its way, leaving behind an exact reproduction of the original pattern. It is stated that with this type of machine, which is made in a variety of sizes for power and treadle, any piece of wood carving may be reproduced with the utmost accuracy and without any skill on the part of the operator. A small machine to be fixed to the bench is shortly to be brought out. The machine is the invention of Messrs. Tyler and Ellis, and is being introduced by the Pneumatic Wood-carving Machine Syndicate Limited, of 1, Gresham Buildings, Basinghall-street, London, E.C.



Pneumatic Wood-carving Machine.

The Labour Department of the Board of Trade has arranged with local correspondents connected with labour organisations in twenty districts, including all the great centres of manufacturing industry throughout the United Kingdom, to supply information with regard to matters affecting labour in their respective districts.

Automatic Water-gauge Stopper.

During the last few years several automatic safety water gauges have been introduced, with a view to minimise the danger to engineers and stokers due to the bursting of gauge glasses. In the illustrations herewith we show a safety attachment which is being placed upon the market by Mr. James Baldwin, of Devonshire Brassworks, Keighley, and which may be attached to any existing water-gauge fittings. The construction of the device will be understood by referring to Fig. 1, which represents a section through the attachment. It will be seen that it consists of a special form of socket, one end of which is screwed on to the end of the gauge fitting, as shown in Fig. 2, while the other end is slightly conical in form and contains a ball as shown.

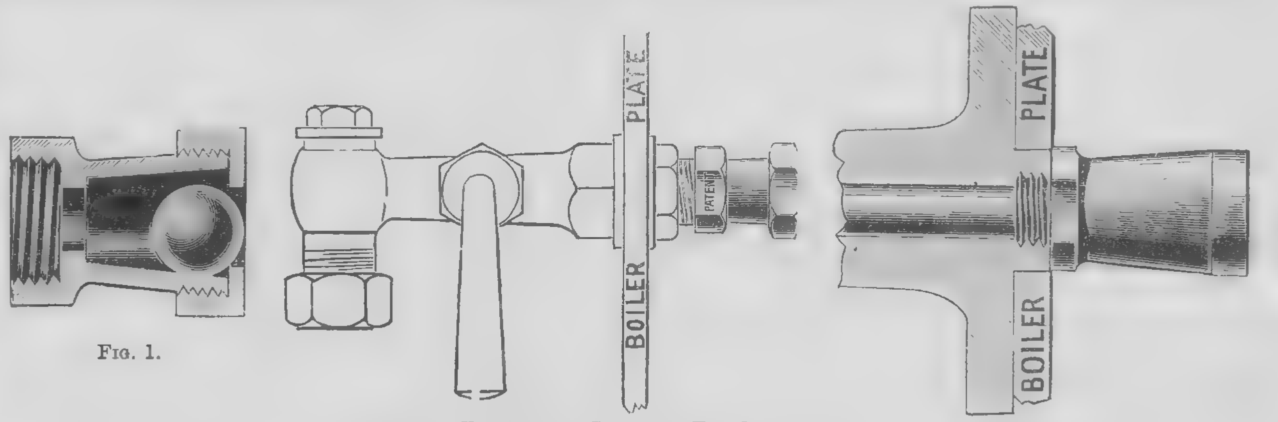


Fig. 1. Automatic Water-gauge Stopper.—Fig. 2. Fig. 3.

In the event of the glass breaking the ball is instantly forced to its seat at the small end of the cone, the escape of steam and water being thereby immediately stopped. When a new glass has been fitted, the valve, not being perfectly steam and water-tight, allows a small leakage to occur, which speedily equalises the pressure on both sides of the ball, which then automatically rolls back into its normal position. Fig. 3 shows the method of attaching the stopper in locomotive and other types of boilers where the gauges are connected to the plates by means of flanges. As will be seen, the attachment is very simple, and is not likely to get out of order, while it can be applied to any existing boiler fittings. It should be noted that although the ball instantly flies to its seat when a sudden escape of steam takes place, yet by opening the bottom gauge slowly the gauge can be readily blown through, as the ball then retains its normal position. The invention appears to offer a simple and inexpensive method of fitting existing gauges with a reliable automatic safety attachment.

Electric Lighting of Boulogne.

This town has been provided with electricity works, the central station being situated at one side of the locomotive shed of the Northern Railway Company, and at a distance of over 1200yds. from the town. It was therefore necessary to erect a secondary battery station, which is arranged on the three-wire system of distribution. The generating station contains two steam engines, each of 125H.P., which drive by means of countershafting two Desroziers dynamos, giving 250 ampères at 300 volts, and a smaller dynamo which serves to charge the accumulators used to light the railway station. The mains are laid partly underground, and are partly carried overhead. The battery station contains 130 cells, having a discharge of 400 ampères.

Notes on the Steam Injector.

(*Continued from page 67.*)

Development. — Having established beyond a doubt the power of a discharging jet of steam to lift a mass of feed-water many times its own weight and force it against the initial pressure, it became necessary to entrust to the hands of a practical mechanical engineer the constructive details of the new boiler feeder. The arrangement decided upon could not, in the light of subsequent events, be considered as an entire success, as it contained inherent defects that caused frequent failures and prevented the placing of as much confidence in the new boiler feeder as the merits of the invention deserved. Many locomotives that during the first burst of enthusiasm were equipped with two injectors were afterwards altered so as to have a pump upon the left-hand side, to be used in case the injector should refuse to work, and it was not until 1875 or 1876 that more recent improvements in construction restored the confidence that the original defects had forfeited, and the pump was driven from service upon locomotives in the United States. Even yet upon some of the English railways a pump is used on one side of the engine, arranged somewhat in the manner of the pressure or vacuum pump for the air brakes.

The curves of the tubes and nozzles as laid down by Giffard were beyond criticism, and are still used where this type of injector is manufactured. His thorough knowledge of the laws governing the action of the jet and the accelerating velocity of the moving mass enabled him so to construct the curves of approach and recession that they have been used as a prototype for all subsequent forms of injectors. Except for one change advanced by our increased information regarding the action of steam during expansion, and a few minor modifications for economy of manufacture, or for adapting the injector to special purposes, no change in the contour of the tubes has been made.

But that there has been development cannot be denied. It may be considered as following three lines :—

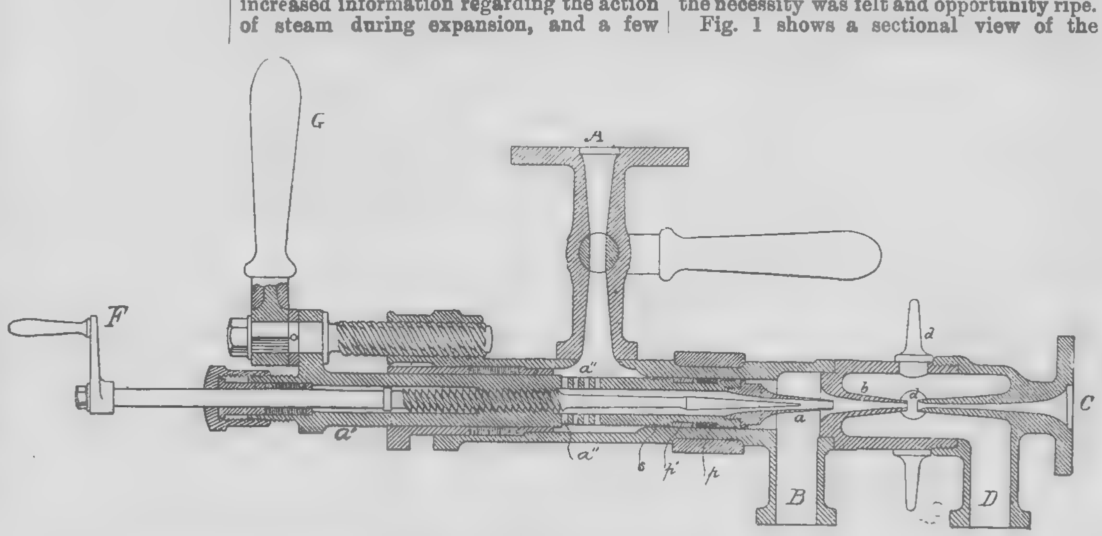
1. Constructive changes.
2. Carrying out the ideas suggested by Giffard in his pamphlets or patent specifications.
3. The discovery of new properties of the jet, or the application of new principles.

Almost all important inventions follow in this natural sequence during their development, and the injector was no exception to the rule. Genuine mechanical ability is seldom combined with inventive genius, and it almost always follows that the fullest development is obtained in other hands than those of the original inventor. The first improvements were, therefore, in the line of correcting the defects that became apparent after the injector had been subjected to the test of actual service; changes required to facilitate repairs or the adjustment of the positions of the tubes. In the second division lies the basis of many subsequent improvements that have since proved very valuable, and Giffard has never been given sufficient credit for his wonderfully wide grasp of the possibilities or future development of the injector. Of the third there will be less to relate, as the only real advance has been with the discovery in 1865 of the peculiar property of the moving jet by which the instrument was made self-regulating, and with the novel arrangement of tubes by which the restarting feature was added.

Injectors now placed upon the market by our most reliable makers combine most of these improvements and leave little to be desired, and it is difficult to anticipate, says a writer in "Engineering Mechanics," the direction in which material improvement can be made.

The general appearance of the injector as now constructed is entirely different from the original form, and it would be exceedingly difficult for anyone not specially familiar with the subject to recognise one made in 1858. The arrangement of the adjusting handles, peculiarly shaped body, and queer little peep-holes present to the modern eye a very odd appearance, while the heavy flanged pipe connections and steam cock do not contrast at all favourably with the neater form then adopted for use on American boilers; but the absence of all moving parts, and the economy due to the return of the actuating steam to the boiler, at last made such an impression, that the inertia of the popular mind against innovation was gradually overcome and the defects of construction overlooked. Improvements have since been introduced as the necessity was felt and opportunity ripe.

Fig. 1 shows a sectional view of the earliest form of injector manufactured for public sale, and was intended for use on either stationary or locomotive boilers. It was made entirely of brass, with the body composed of three pieces, screwed and bolted together, and the steam, feed, and boiler connections terminating in flanges, as is still the general practice in England and on the Continent. The method of starting and operating the injector was as follows :—Upon opening the cock A, steam from the boiler passed freely into the steam ram a' through the small drilled holes a''. The spindle, which had been previously forced down to a tight bearing against the taper steam nozzle a, was drawn back one turn of the handle F, exposing an annular area approximately



Notes on the Steam Injector.—Fig. 1.

one-quarter that of the end of the tube *b*. The rapid discharge of the steam through the combining tube *b* entrained the air in the suction branch B, and formed a partial vacuum in the feed-pipe which raised the water to the injector. The spindle was then drawn fully back, and the increased discharge of steam imparted to the surrounding body of water, during its passage through the combining tube, sufficient velocity to cross the overflow space *d* and enter the boiler through the delivery tube *c*.

Assuming the correct relation to exist between the discharge area of the steam nozzle and the annular entrance area for the water at the larger end of the combining tube, the steam will force into the boiler many times its weight of water, without tendency to spill at the overflow *d*. If change take place in the pressure of the steam or of the feed-water, one of two conditions will be introduced, depending upon the direction in which the change of pressure occur—either there will be an insufficient supply of water for perfect condensation during the passage of the jet through the combining tube, or too great a quantity of water will enter the injector to pass through the delivery tube *c*. It was to allow for this that Giffard introduced two adjustments—one for the water area, by giving an axial movement to the ram and steam nozzle by the lever G, and the other for the steam discharge area by the handle F on the spindle. If the pressure of the steam or the lift of feed-water were increased, it was necessary to draw the steam ram further back to permit the admission of a larger quantity of water, while a fall of pressure would require a reverse movement. This necessity for readjustment was so frequent upon locomotives where the pressure was subject to wide fluctuation that the packing upon the steam ram soon wore loose and gave constant trouble, allowing leakage to occur between the steam and feed chambers, impairing seriously the efficiency of the injector and its power of suction. This packing was formed in an ingenious manner, although in service it proved ineffective, and no device has yet been introduced that has proved thoroughly reliable for this purpose. The ram was provided with three kinds of packing. The lower part was first turned slightly larger than the bore of the body, and small triangular grooves *s* turned, not spirally, but in planes normal to the axis. The ram was then driven to place, forcing the tops of the sharp edges backward and reducing it to the same size as its bearing. A deeper groove *p'* was filled with rubber or hemp, and a second groove *p* with a split metallic ring; while another set of V's was placed between the ring and the steam nozzle. Upon the body of the injector, and directly opposite the overflow *d*, four peepholes were placed and covered by a sliding ring with handles *d'*. This could be rotated until the holes in the ring were opposite those in the body, and permitted the inspection of the condition of the passing jet. When new and in good condition this injector worked very well, and its double adjustments gave it long wearing power. Any ordinary increase in the diameter of the nozzle due to the attrition of the rapidly-moving jet could be counteracted by a change in the areas, although at a reduction of the efficiency.

(*To be continued.*)

Efficiency of Hydraulic Passenger Elevators.*

MODERN ELEVATORS for passenger service are usually operated by means of a piston driven by hydraulic pressure, a method which fulfils very well the requirements of ease of handling combined with smooth and rapid motion of the car. The hydraulic piston carries at the outer end of its rod one or more grooved pulleys, or sheaves, around which the wire ropes supporting the elevators are passed. By taking a sufficient number of turns of the ropes around these sheaves and other fixed sheaves, the speed of the elevator can be made any desired number of times greater than that of the piston. There are two principal methods in use for obtaining the water pressure necessary for propelling the piston—namely, the pumping or tank system and the hydro-steam system.

By the former, which is the older system and the one at present in more common use, the water pressure is derived either from an open tank on the roof, or from a closed tank having the upper part filled with air under the required pressure. In cities, or other places where water is expensive, the water which has done its work is received in a waste tank in the basement, from which a steam pump returns it to the pressure tank, the same water being used repeatedly. The choice between an open or closed pressure tank depends upon circumstances. The closed tank has the advantage that it can be operated under as high pressure as may be desired, while the pressure from an open tank is limited by the height of the building. On the other hand, the open tank permits a somewhat more regular, and therefore more economical, action of the pump.

As the system is generally arranged, the upper side of the hydraulic piston is always in communication with the pressure tank. When the controlling valve is adjusted so that the water under the piston can escape, the piston is driven down, and the elevator car is raised. To lower the car a passage is opened between the two ends of the hydraulic cylinder, thus equalising the pressure on the two sides of the piston. The latter is then raised by the unbalanced weight of the car, the water flowing around from the upper to the lower end of the cylinder. As the weight of the car is usually more than is necessary to give the desired speed in lowering, a part of it is counterbalanced by an iron weight, which serves also to reduce the work done by the water in lifting the elevator.

In the hydro-steam system the water acts only on the upper side of the piston. The counterbalance consists of a column of water contained in a closed cylindrical vessel called a receiver, located at such a height above the hydraulic cylinder as will give sufficient pressure to balance the desired fraction of the weight of the car. The connection between the piston and elevator car is by means of wire ropes passing around multiplying sheaves, as in other hydraulic elevators. When it is desired to raise the elevator, steam from the boiler is admitted to the top of the receiver, and, pressing on the surface of the water, forces it down into the working cylinder, driving the piston before it. To lower the car, the steam is allowed to escape from the receiver, when the weight of the car lifts the piston and the column of water resting upon it, the water being forced back into the receiver. By closing a valve in the water passage between the cylinder and receiver, the elevator is stopped and held at any desired point. It is evident that with this system of working no pumping machinery is required. The successful operation of the hydro-steam system depends largely upon the perfect action of the water and steam valves.

The question of the comparative efficiency of the two systems is reduced to the question whether, under the conditions of elevator service, more work can be done upon a hydraulic piston by applying steam pressure directly to the surface of the water, or by using the same quantity of steam to pump water into a tank from which the supply for working the elevator is drawn. It is evident that in the hydro-steam elevator the principal loss will be that due to the condensation of the steam on the surface of the water and on the comparatively cold sides of the receiver. This loss is reduced as much as possible by clothing the receiver with non-conducting material, and by preventing the agitation of the surface of the water by the entering steam. It is to be remembered, also, that in this apparatus the steam is always brought in contact with the same body of water, which remains permanently at a temperature of about 212° F.

In the pumping system, especially if a compound pump is used, the losses by condensation of steam will be smaller, but we have added losses due to leakage and friction in the pump and pipes. Moreover, under this system, all the water used has to be pumped against a pressure sufficient to raise the heaviest loads which the elevator has to carry, and just as much water, and, consequently, as much steam, is required to raise the elevator empty as to lift it with a full load of passengers. On the other hand, in a hydro-steam elevator, by applying a throttling governor, similar to the governor of a steam engine, to the steam supply pipe, the quantity of steam used on each trip of the elevator can be adjusted to correspond to the load carried, and a considerable saving made. By this method, also, the speed of the elevator is kept the same under all loads within the limit of its capacity. The attendant has only to open the steam valve wide, and as soon as the desired speed is attained the governor acts and prevents a too rapid motion.

It appeared to the writer that the only reliable way of striking a balance between these opposing elements of economy, would be by means of an accurate test of the two methods under the actual conditions of practice in passenger service.

Two tests were made to determine the relative economy of the two systems. The first test was of a hydro-steam passenger elevator in an office building, having a capacity of 10 persons and an average speed of about 300ft. per minute. The whole travel of the elevator is about 60ft., being three times that of the hydraulic piston. The cylinder is vertical, $12\frac{7}{16}$in. in diameter, and the piston rod diameter is 2in., making the effective area of the working piston 118sq. in. The test was of about six hours' duration.

For the second test a Knowles compound duplex pump of the latest pattern was used, which supplies water for ten elevators operated on the open tank system. The elevators are of the Otis vertical cylinder pattern.

The whole quantity of steam supplied to the hydro-steam elevator during its test was 2057lb., and the total travel of the working piston in lifting the car during the same time was 4181ft. The effective area of the piston being 118sq. in., the volume of water that would be required to do this work under a pumping system would be $4181 \times 118 \div 144$, or 3426 cubic feet. The maximum effective pressure realised on the piston of the hydro-steam elevator was 77·3lb., and calling the ratio of pump pressure to effective pressure on the piston 1·25, the pump would have to force this volume of water against a pressure of $77{\cdot}3 \times 1{\cdot}25$, or 96·6lb. per square inch. The quantity of work represented by these figures is 47,658,383ft.-lb., which, divided by 2057, gives us the number of foot-pounds per pound of steam as 23,169. This is what a pump must do to equal the performance of the hydro-steam elevator under the conditions of this experiment.

The actual performance of the pump tested in foot-pounds per pound of steam was 23,234. The difference being less than three-tenths of one per cent., the writer concludes that the efficiency of the hydro-steam elevator as at present in use for passenger service is about equal to that which can be obtained with tank elevators operated by a good compound pump. Compared with the performance of the non-compound pumps often used for elevator work, the hydro-steam system would, therefore, have a considerable advantage; and a further advantage may be gained, doubtless, by the use of the throttling governor in the steam pipe.

It is interesting to notice that the quantity of steam actually used per trip by the elevator in these experiments was about three times what would have been required to fill the receiver if there had been no condensation. A rough calculation also shows that the heat required to raise the temperature of the iron sides of the receiver from 212° to the temperature of the entering steam is sufficient to account for the greater part of the condensation. It is therefore probable that a comparatively small proportion of the steam is condensed on the surface of the water, the depth affected being very small.

*Abstract of a paper read by Prof. H. B. Gale before the Technical Society of the Pacific Coast.

Metal Trade Memoranda.

The export of tinplate from Great Britain to the United States during the month of January was 23,498 tons.

It is reported that at Great Coggeshall, near Braintree, Essex, a seam of coal has been found at a depth of about 1400ft.

The two large blast furnaces at the Thorncliffe Ironworks, after standing idle for three weeks, have been put in blast again.

Great Britain exported agricultural machinery to Australasia during January last to the value of £6385, as compared with £4013 in January, 1892.

The total output of gold in the Witwatersrandt districts during the month of February amounted to 93,252oz., against 108,374oz. in January and 117,748oz. in December. In February, 1892, the output was 86,649oz.

The Glasgow Iron and Steel Company have commenced to take down two of their blast furnaces at Wishaw, and intend replacing them by others of an improved type. They have also commenced to lay down a Siemens steel plant.

The February return of the Cleveland Ironmasters' Association shows the following as the month's make of pig iron—namely, 113,000 tons of Cleveland iron and 97,000 tons of other kinds, a total of 210,000 tons, or 21,000 tons less than in January. There are 89 furnaces blowing, 52 of which are making Cleveland iron. The stocks increased 28,506 tons in February.

The development of the mineral resources of Newfoundland is proceeding in a steady manner. The exports of copper ore were larger last year than during the previous year, and new deposits have been discovered. The asbestos mines on the west coast are very promising. Coal has been found near Grand Lake, and one trough, containing several seams of coal, extends for 15 miles along the south shore of the lake.

The Metal Market.

PRICES CURRENT.

LONDON, March 13.

COPPER opened firm, £45 5s. being paid for cash in a week, and with light offers and a good cash inquiry a rise to £45 6s. 3d. was afterwards made for a few days prompt, it being anticipated that the bi-monthly figures will show a substantial decrease in stocks. Three months ruled at £45 15s.; cash at £45 6s. 3d., and £45 7s. 6d. was paid towards the close for ten days prompt, the market finishing at the best with buyers at £45 6s. 3d. cash, or 1s. 3d. advance on Friday's latest business. Sales, 600 to 700 tons. Settlement price, £45 5s. English tough, £48 15s. to £49; best selected, £49 15s. to £50. Strong sheets, £57.

TIN opened with operators holding back, and it was late in the first session before business was effected, £94 15s. being paid for cash, at which there were buyers on Friday, but later three months declined 5s., to £94. Cash, however, ruled steady at £94 15s., the public business being limited to about 60 tons, although this was much exceeded by private deals, which were governed by Friday's values for May dates. The market has again been ruled by American interests. The close is steady at a partial loss of 5s. Settlement price, £94 15s. English ingots, £98.

PIG IRON was inactive until the second session, when 2000 tons Scotch changed hands, one month at 41s. 2½d. and three months open buyers' option at 41s. 9d., and the close was steady at 1½d. to 2d. decline. 500 tons Middlesbrough cash were reported sold after official hours at 34s. 9d., and closed 1d. better than Friday. Settlement prices: — Scotch, 41s.; Middlesbrough, 34s. 10d.; hematite, 46s. 1d.

TINPLATES quiet at late rates, I.C. cokes, f.o.b. London, 12s. 7½d.; Liverpool, 12s. 1½d.; Swansea, 11s. 7½d.

LEAD has ruled steady: Spanish, £9 18s. 9d. sellers, £9 17s. 6d. buyers. English, £10 2s. 6d.

SPELTER closed steadily after business at £17 15s. for ordinary and £17 17s. 6d. for special brands, March shipment.

ZINC SHEETS.—Silesian ordinary, ex ship has sellers at £20 15s. Belgian steady; V.M. brand, £20 17s. 6d. ex ship and £20 15s. f.o.b. Antwerp.

OFFICIAL CLOSING QUOTATIONS.

	To-day. £ s. d.	£ s. d.
COPPER—		
G. M. B.—Cash	45 6 3	—45 13 9
" Three months	45 15 0	—46 2 6
TIN—		
Fine foreign—Cash	94 15 0	—95 5 0
" " Three months	94 0 0	—94 10 0
Australian—Cash	95 5 0	—95 15 0
PIG IRON—		s. d.
Scotch warrants—Cash		41 0
" One month		41 2½
Middlesbrough—Cash		34 10
" One month		35 0
Hematite—Cash		46 1½
" One month		—

GLASGOW, March 13.—The pig iron market was very quiet. At first tone was flat, but a few purchasers sufficed to stiffen prices. Scotch cash moved between 41s. and 41s. 2½d., while month contracts varied between 41s. 2d. and 41s. 4½d. Nearly 6000 tons Scotch changed hands, the bulk of it at the cash figures. The shipments last week were good, aggregating 8376 tons, an increase of 4478 tons on the corresponding week, and reducing the decrease on the year to only 1605 tons.

QUOTATIONS:—

	Scotch. Cash. s. d.	Scotch. 1 m'th. s. d.	Middlesbrough. Cash. s. d.	Middlesbrough. 1 m'th. s. d.	Hematite. Cash. s. d.	Hematite. 1 m'th. s. d.
Highest	41 2½	41 4½	34 10	35 0	46 1½	—
Lowest	41 0	41 2	34 10	35 0	46 1½	—
Close	40 0	41 2½	34 10	35 0	46 1½	—
Prev. close	41 2	41 4	34 8	34 10½	46 1½	—

New Companies.

H. SPENCER AND CO. LIMITED.—This company was registered on the 4th inst., with a capital of £15,000, in £5 shares, to acquire the undertakings of "H. Spencer and Co.," of Workington, and to carry on the business of ironmasters, colliery proprietors, coke manufacturers, quarrymen, miners, smelters, metal workers, etc. The number of directors is not to be less than 3, nor more than 5; qualification, £5; remuneration to be fixed in general meeting. Registered by Drake, Driver and Leaver, Rosebery-avenue, E.C.

OSWESTRY ELECTRIC LIGHTING AND POWER COMPANY LIMITED.—This company was registered on the 2nd inst., with a capital of £10,000, in £1 shares, to carry on the business of a company for the supply at Oswestry, or elsewhere, of electricity in all its branches, and in particular to supply by electricity light, heat, and power to any person, firm, company, or corporation, municipal or local authority, and to create, accumulate, and distribute electricity, magnetism, or any other similar agency. Registered, without articles of association, by Jordan and Sons, 120, Chancery-lane, E.C. Registered office, Oswald-road, Oswestry, Salop.

ELECTRIC ANTI - CORROSION COMPANY LIMITED.—This company was registered on the 2nd inst., with a capital of £6000, in £10 shares, to acquire and purchase an invention for which a provisional protection has been granted, dated March 22, 1892, and numbered 6105[92]; also French patent numbered 223,664[92]; and Italian patent, numbered 472[92], to enter into a certain agreement made between J. Tellefsen and J. Bennett, to acquire any suitable trade mark, and to exercise and turn to account any patents acquired by the company. The rules of Table A generally apply. Registered office, 72, Bute-street, Bute Docks, Cardiff.

QUEEN'S FERRY SHIPBUILDING AND ENGINEERING COMPANY LIMITED.—This company was registered on the 7th inst., with a capital of £3000, in £1 shares, to acquire from G. Logan, of 23, Island-road, Garston, marine engineer, the whole of the stock, plant, and machinery recently belonging to Finch and Kelly, of Liverpool, iron merchants, in and upon or about the yard occupied by them at Queen's Ferry, Flint, and known as the Queen's Ferry Shipbuilding Works; and to carry on the business of shipbuilders and engineers. The rules of Table A generally apply. Registered by Kerr and Lanham, 3, Chichester Rents, W.C.

EBENEZER TIMMINS AND SONS LIMITED.—This company was registered on the 3rd inst., with a capital of £20,000, in £20 shares, to acquire and take over as a going concern the businesses of engineers, ironfounders, contractors, heretofore carried on at Runcorn, Chester, and elsewhere, under the style of Ebenezer Timmins, and to carry on the business of civil, mechanical, electrical, marine, artesian well, and general engineers, ironmasters, brassfounders, metal workers, metallurgists, shipowners, and all auxiliary trades. The number of directors is not to be less than 3, nor more than 7, the first being W. Timmins, T. D. Timmins, C. A. Timmins, A. Timmins; qualification, life directors, £1000, ordinary directors, £200; remuneration to be hereafter determined. Registered by Robinson, Preston and Stow, 35, Lincoln's Inn Fields, W.C.

WOLVERHAMPTON CORRUGATED IRON COMPANY LIMITED.—This company was registered on the 7th inst., with a capital of £75,000, in £10 shares, to take over and to carry on the business of galvanised iron manufacturers, carried on by the Wolverhampton Corrugated Iron Company at the Shrubbery Works, Wolverhampton, Staffordshire, and also the business of iron manufacturers and masters, carried on by the Shrubbery Steel and Iron Company, at the Stour Side Works, Wolverhampton, and to carry on the business of manufacturers of galvanised, tinned, corrugated, curved, flat, and plain sheet iron and steel, cold rolled and close annealed iron or steel, etc. The number of directors is not to be less than 3, nor more than 7, the first being O. Jones, J. Jones, J. H. Jones, E. P. Jones, and E. Farnworth; qualification, £100; remuneration to be fixed in general meeting. Registered by Miller, Smith and Bell, 3, Salter's Hall Court, E.C.

Official Gazette.

Partnerships Dissolved.

H. T. RATCLIFF and H. FOSTER, under the style of Ratcliff and Foster, Wednesbury, tube and fitting manufacturers and galvanisers.

J. DEACON and J. A. FOSTER, under the style of Deacon and Foster, Birmingham, engineers and machinists.

C. RUSSELL, J. RUSSELL, and W. C. KEABLE, under the style of W. C. Keable and Co., Perry Barr, Staffordshire, boiler composition manufacturers; so far as regards W. C. Keable.

W. T. CROSSE, A. V. WRIGHT, and W. J. BLAKISTON, under the style of Isaac Dixon and Co., Liverpool, manufacturers of iron buildings; as far as regards A. V. Wright.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Receiving Order.

ARTHUR HENRY WRIGHT RADCLIFFE, Handsworth, late Castle Bromwich, Warwickshire, and Birmingham, electrical and telegraph engineer.

Order made on Application for Discharge.

FREDERICK GEORGE WILLIAMS (trading as Kenyon and Co.), Denton, Lancashire, electrical engineer—discharge granted, subject to the payment forthwith to the trustee of the sum of £193.

Letters to the Editor.

⁂ We do not hold ourselves responsible for opinions expressed by correspondents.

⁂ The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.

⁂ Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

THE AVOIDANCE OF SMOKE.

To the Editor of THE MECHANICAL WORLD.

SIR,—If "W." will kindly look again at my letter which appeared in your issue of February 24, he will see that I did not refer at all to gas for illuminating purposes, nor did I specially mention gas engines. What I want to impress is that the manufacturing world can have its present plant worked without a particle of smoke for any moment of time, not by any mechanical contrivance for the consumption of smoke, but by using a fuel that will not produce smoke. I want, further, people to understand that this is a more economical fuel than coal, and that manufacturers would effect a large saving by using it. "The use of crude coal for any purpose is little short of insanity," is an expression which appears in a pamphlet on the subject by the late Sir W. Siemens.

Whether coke should be used with the gas or not depends upon circumstances. Where there is a good demand for coke—no. Where coke is a drug—yes.

I should very much like to bring this matter to a practical issue. I have pointed out that some people in Yorkshire have been, and are now, working their boilers by gas, and save largely by doing so, and have not a sign of smoke at any time; but people will not go far afield to inspect that in which they do not believe.

Let me make this offer. If ten manufacturers will subscribe £50 apiece, I will undertake to have the process applied to two boilers at each of their works, and they shall each save £50 a year (100 per cent. per annum), and have no smoke at any time. All I should do to the boilers is to take out the firebars and block the entrance, to prevent cold air getting in.

This offer ought to satisfy "W." that "a non-smoke process is provided which will be more economical than those at present in vogue." No matter what economy is effected by mechanical stokers or other appliances, they are "not in it" with gas supplied with hot air under pressure.

T. NICHOLSON.

Tudno Villa, Colwyn Bay,
March 13.

Miscellaneous Items.

In the Naval Estimates for 1893 the Government set apart £2050 for the erection of electrical workshops at Chatham.

The German Patent Office received last year 13,126 applications, and granted 5900 patents, against 12,919 applications and 5550 patents in 1891.

At an ordinary meeting of the Institution of Civil Engineers, held on the 7th inst., a paper was read descriptive of "Plant for Harbour and Sea Works," by Mr. Walter Pitt, M. Inst. C.E.

The central station at Athens, Greece, is now supplying current to 93 arc and 7200 incandescent lamps, as well as to 11 electric motors. During the past year the capacity of the station has been increased by the addition of two 150 horse-power steam dynamos. The system of underground mains has also been increased.

A new street indicator for electric tramways has recently been tried at Albany, N.Y., U.S.A. The indicator is placed inside the car over the door, and consists of a series of narrow signs so arranged that only one is visible at a time. The indicator is operated automatically by means of an electric current taken from the overhead conductor.

The great clock of St. Paul's has been taken down from its lofty height, and is to be replaced by one of modern construction. Why this piece of vandalism should be perpetrated it is difficult to imagine. The clock, which was put up by Langley Bradley in 1708, is in splendid condition, and might to all appearance go on for another two centuries without failing to bear accurate record of the passing time. It is a grand old clock, remarkable for the magnitude of its wheels and the fineness of its works. It cost £300 to build. Its two dial plates are 51ft. in circumference, and the hour numerals 2ft. 2½in. in height. The minute hands are 9ft. 8in. long, and weigh 75lb. each, and the hour hands are 5ft. 9in. long, and weigh 44lb. each. The pendulum is 16ft long. It is an eight-day clock, striking the hour on the great bell, which is suspended about 40ft. from the floor. The head of the hammer weighs 145lb., and the clapper 180lb.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

IRON MANUFACTURE.—Required, particulars of the Husgafel process of making iron blooms direct from the ore.—F. C.

RAIL CROSSINGS.—Given the gauge and the angle of crossing of rails, what rule is generally adopted to obtain the radius of the curve and the rails?—R. A. J.

DYNAMITE.—Why does dynamite, when it explodes, penetrate farther and with greater force into a stone (or other substance) in a downward direction than gunpowder?—T. D.

ENGINEERS' WAGES.—Would any reader kindly give me some information as to the wages at Cape Colony and Mexico for mechanical engineers?—REGULAR READER OF "THE MECHANICAL WORLD."

METALLIC PAPER.—Could any reader inform me how paper can be prepared for taking indicator diagrams upon, with brass or iron point, to give a clear erasure with the slightest pressure?—M. H. M.

RUST JOINTS.—How can I stop leakage in a vertical joint (rust joint) in my hot-water pipes (low-pressure system) without cutting out the packing? Would any fluid cement percolate into the crevices and harden there?—B.

MAKERS OF BUILDERS' IRONWORK.—Can any reader furnish me with addresses of firms who are makers of machinery for making builders' ironwork, such as bands and hooks, cavity irons, etc.?—SMITH.

ELECTRICAL RESISTANCE.—Can any reader give me any information relative to the resistance offered to the passage of electricity by carbon rods and platinium wire? Is there a small work published on the subject? If I had formula, I could work out myself.—CARBON.

ELECTRIC TROLLEY.—I am in want of a trolley to carry about 3 tons a short distance on a good road nearly level. Can I get one to be self-propelling, and what would be the best kind of motor? I shall be glad if any reader can inform me where anything of this kind can be seen—CORN MILLER.

COKE OVENS.—Will any reader of THE MECHANICAL WORLD give me particulars for erecting coke oven plant—viz., beehive ovens? Also particulars of flues for the erection of steam boilers to raise steam from the waste gases from ovens; or state the best works on the above?—COKER, J. C. S.

ELECTRICAL TRAP.—Can any reader of THE MECHANICAL WORLD inform me how to make an electrical trap for catching snakes, reptiles, etc.? I believe they are working successfully in India. Could I make one by enclosing a space and running bare wires round it, and charge by battery?—GEORGE PERKINS (North Queensland).

CONVEYING DEVICE.—I want to remove cut straw, ⅜in. long, from chaff cutter to a room distance 60ft., round one curve, at the rate of 5 tons per hour. What size tube shall I require, and how can I do it by means of a blast fan so that the chaff does not go through the fan? Would sanitary tubes do for the purpose, underground?—PUZZLED.

FACING SLIDE VALVE FACES.—I require a hand appliance, not expensive, suitable for getting up the faces of slide valves of portable, traction, and other engines, say when the valve face is some 3in. to 5in. from the valve-chest cover face. Are there no small hand-lever appliances which can be screwed on to a stud and used for working a broken file or similar tool?—NESCIENCE.

WASTE CLEANING, ETC.—(1.) I shall be much obliged for any information regarding the washing and cleansing of used waste and the filtering of oils; also the machinery necessary for same, cost, etc. (2.) The machinery involved in the grinding of bones to ash for chemical purposes, etc., or most economical way of doing same by furnaces, etc.; the cost of plant, etc.—A. F. L., South Africa.

DYNAMO SHAFT.—I should be much obliged if the author of "The Design and Construction of Stationary Engines," or some other reader, could give me a formula (or refer me to any book where I could find it) for arriving at the size of shafts for dynamos and motors; given distance between bearings, weight of armature and pull on periphery of same in lb. Any information with respect to this would be much appreciated.—A YOUNG ELECTRICAL ENGINEER.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

SHEARS.—No address given.

T. E. D.—See reply to "Shears."

H. L. H.—Thanks for your letter.

APPRENTICE.—We cannot understand your query. Send a sketch.

H. HALLA.—Binn's "Projection," 10s. 6d., will suit you. It may be had from our office.

J. S. C.—We should think a good Babbitt metal would suit you, or Magnolia metal.

J. T. F.—No, they are not suitable for muddy water. Cannot you filter the water before using?

KISHNA (India).—Apply to Mr. Alfred Bache, Secretary, 19, Victoria-street, Westminster, London, S.W.

ANXIOUS ONE.—Box's "Mill Gearing," 7s. 6d.; Jamieson's "Steam Engine," 3s. 6d. Both may be had from our office.

R. S.—We do not know the lubricator in question. If you send us a sketch we will endeavour to assist you.

J. B.—We can supply either of the books. Courtney's is 2s., and Foden's 5s. We think the former would best suit you.

DRAUGHTSMAN.—We do not think they can be obtained in this country, but you might inquire of Mr. Stanley, Great Turnstile, Holborn, London.

HARRISON AND CO.—The alloy containing 50 parts of tin, etc., is the Babbitt. You can run the metal as you propose if the journal is in good condition.

W. M. NICHOLS.—You are, generally speaking, correct in your views. You will, however, find the matter fully explained in the articles now appearing.

GARNOCK.—"First Principles of Mechanical Engineering," Jamieson's "Steam Engine," Wilson's "Steam Boilers," D. K. Clark's "Rules and Tables," and Unwin's "Machine Design."

H. C.—The rule for flat valves—viz., lift = ¼ diameter—is based upon the fact that the circumferential opening thus obtained is equal to the area of the full valve opening. Applying the same reasoning to your case, the distance marked A should be taken, as this is the minimum.

J. J. HALSALL.—(1.) For compound condensing engines from 8lb. to 10lb. per sq. in. may be adopted as a terminal pressure. In non-condensing, about 20lb. or 22lb. (2.) Yes, divide the *absolute* initial pressure by the terminal to obtain the ratio of expansion in each case. (3.) The back pressure of 5lb. applies to condensing engines. For non-condensing engines use 18lb.

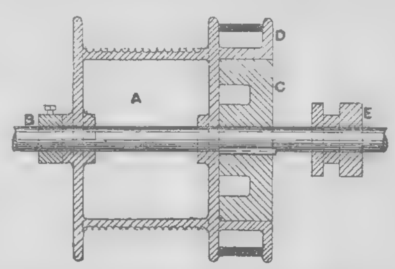
EXHAUST STEAM.—Could any of your numerous readers give me any information as to how to dispose of exhaust steam from a donkey feed-pump, and say if it would be right to put the exhaust steam into the feed-water on the suction side, and what arrangement is required for this? The water is at present 80° F., and the pump has to lift it 12ft. Will the pump work satisfactorily if the exhaust steam be put into water at 80°.—INJECTOR. ——*A.*—It is very common to turn the exhaust steam into the suction side of the pump, and, if properly arranged, should work quite satisfactorily under the conditions named.—G. A.

AIR COMPRESSING STAYING.—(1.) How many cubic feet of air could a 1 H.P. engine force into a chamber against a pressure in the chamber of 11lb. per inch? (2.) What kind of pump or blower would be most useful, economical, and take little room? (3.) What kind and diameter of rods 2½ft. long would be required to stay roof and floor of an iron chamber against pressure from within, each rod to withstand pressure of 60 tons?—A. C. S.——*A.*—If you will give a few more particulars as to the shape and size of the air chamber into which you wish to force the air I might be better able to assist you. It would save time and trouble if querists would give full particulars when asking questions.—G. A.

FEED-WATER HEATERS.—Would someone kindly inform me how to calculate and give all particulars of a plain wrought-iron vertical or horizontal cylindrical feed-water heater; number of tubes, diameter, and heating surface, height and diameter of wrought-iron cylinder, and whether brass or wrought-iron tubes would be best, for an engine with 16in. cylinder by 2ft. 3in. stroke, making 70 revolutions per minute? Steam pressure, 60lb per square inch; cut-off at ⅝ stroke; size of exhaust pipe, 5in. diameter; steam pipe, 4in. diameter; exhaust steam to pass through heater tubes. How much larger would heater have to be for a pair of engines with cylinders as the one above?—FEED WATER.——*A.*—I do not know that there are any special rules for this class of heater. Your engine will probably indicate about 65H.P. and use about 30lb. of water per 1H.P. per hour, requiring about 3) × 65 = 195gals. per hour. The heating surface required for heaters of this type is found approximately by the following formula:—H. S. = gallons per hour × 0·36. In this case heating surface = 195 × 0·36 = 70 sq. ft. Brass tubes are best, and they should be about 6ft. long and 2in. ex. dia. The surface of a 2in. tube is = 0·523 sq. ft. per foot run. The number of tubes required will therefore be

$$\frac{70}{6 \times 0{\cdot}523} = 22{\cdot}3,$$ say 22 tubes, requiring a heater about 18in. diameter and about 8ft. long over all. The objection to this type of heater is that they are apt to leak, owing to the unequal expansion and contraction due to the varying temperatures of the water. This can be got over to a great extent by forming the tube plate, so that they will yield to the expansion of the tubes. This is commonly done by turning the plates slightly thinner close to their outer edge, where they are held between the flanges. In heaters of this form a pocket, or settling receptacle, should be formed in its under side, to allow the impurities in the water to deposit, and provision made for blowing off the sediment at intervals.—G. A.

HOISTING GEAR.—The sketch represents an arrangement for hoisting by means of a friction clutch, and consists of a winding drum A (with spiral turned groove for line rope) running loosely on a turned shaft, and kept from moving laterally on shaft by means of a set collar B and friction clutch C, which is keyed on shaft. On the right-hand side of drum is cast a shell D, which is turned on its inner surface. Engaging with this is a friction clutch of the ordinary type with an expanding friction ring, which is expanded by means of a sleeve E actuated by means of a lever. I propose to wind up goods by means of friction clutch, and when the rope has reached the necessary height the load will be sustained by means of a strap brake. Lowering is also managed by means of brake, the



clutch being disengaged. What I require is to find out the proper size of friction clutch—*i.e.*, diameter of ring and width, also dimensions of brake wheel, and kind of brake most suitable. The data are as follow:—Tension of wire rope, 2800lb.; diameter of winding drum, 1·75ft.; velocity of drum, 10 revolutions per minute; speed of rope = circumference or 1·75 × 10 = 5·5 × 10 = 55ft. per minute; H.P. required to do the work = 4·7H.P.; and allowing for, say, 70 per cent. efficiency, the actual H.P. = 6·7H.P.—C. PARCIVAL.——*A.*—Assume the inner diameter of friction clutch ring to be 24in. The pull at the circumference of this part will be $\frac{2800 \times 21}{24} = 2450$lb., which will have to be overcome by the frictional resistance to slipping of the inner clutch ring. The coefficient of friction of cast iron on cast iron may be taken at 0·15. The radial pressure required will therefore be $\frac{2450}{0{\cdot}15} = 16{,}333$lb. The inner expansion ring, I presume, will be expanded by means of a right and left-hand screw. Let p^1 = pitch of screw in inches; l = length of lever in inches operating screw; and P = end pressure required on clutch. We have, according to Reuleaux, the following relation:—$P = 2\,\frac{p^1}{2\pi l};\ \frac{F}{f}$; also $P = \frac{p^1}{\pi l} \cdot \frac{(F R)}{R.}$ F = driving force on circumference of clutch; R = radius of ring; f = coefficient of friction. If $p^1 = \frac{1}{8}$, l = 7in., and f = 0·15, $P = 2\,\frac{\frac{1}{8}}{2\pi l} \cdot \frac{2450}{0{\cdot}15} = 93$lb. This pressure can be exerted either by means of a handwheel and screw, or by means of long lever. The width of the inner ring depends upon the pressure to be allowed on it for wear. The holding power is dependent on the pressure, and independent of the width. For good working the pressure should not exceed 100lb. per square inch. We have then $\frac{16{,}333}{100 \times 452} = 3{\cdot}6$in., say 3¾in. wide. The thickness of the ring to resist bursting pressure may be obtained thus:—Allowing a safe tension of 1 ton per sq. in. for cast iron, we have $\frac{16{,}333}{7{\cdot}5 \times 2240}$ = 1in., say, the required thickness. The outside diameter of the brake ring will now be 26in., and for the dimension, etc., of the brake strap we have first to find the tensions on the two ends of the strap. This is found from Rankine's formula:—Calling the tension T^1 and T^2, we have $T^1 = T^2 \times 10^{2{\cdot}7288 f.c}$; where f = coefficient of friction = $\frac{3}{10}$, and c = ratio of

$$\frac{\text{arc covered by band}}{\text{whole circumferecne}}.$$

The greatest tension will be equal to the pull at the circumference of the brake ring, which is $\frac{2450 \times 24}{26} = 2261$lb. Taking the coefficient of friction at $\frac{3}{10}$, and $c = \frac{9}{10}$ of circumference, we have

$$T^2 = 10^{\cdot 2{\cdot}7288 \times 0{\cdot}3 \times 0{\cdot}9}.$$

This equation requires the use of logarithms for its solution. $10^{\cdot 2{\cdot}7288 \times 0{\cdot}3 \times 0{\cdot}9} = 10^{\cdot 7367}$ = log. 1·7367 = 5·4. Therefore, $T^2 = \frac{2261}{5{\cdot}4} = 418$lb. If we make the long end of hand lever 36in., and the short end 2in., the mechanical advantage will be $\frac{36}{2} = 18$. The power

required to be exerted at the end of the lever will be $\frac{418}{18} = 23{\cdot}2$lb.—a moderate amount. The brake strap should be of wrought iron, 3¾in. wide by $\frac{3}{16}$in. thick, and lined with wood.—G. A.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed

27th February, 1893.

4231 STRAP GUARDS. G W Dyson.
4234 OIL FEEDER for MACHINERY. G H Byrd.
4239 INSTRUMENT for ASCERTAINING the DISTANCES of FIXED OBJECTS from a MOVING OBJECT, such as a SHIP at SEA. R Temperley.
4242 APPARATUS for PROVIDING AGAINST the FAULTY WORKING of SIGNALS. E H Morris.
4245 REFRIGERATING APPARATUS. A Shiels.
4249 PRESSURE GAUGE. F H Orme and J W Collins.
4251 FREEING COPPER from ARSENIC.* F B Stone.
4252 WATER-PIPE CLEANING MACHINE. W Jamieson and J Oswald, jun.
4253 APPARATUS for REGULATING, CONTROLLING, and FEEDING WATER to STEAM BOILERS. G J Beedham.
4254 SHAFT BRACKETS and BEARINGS. G A Clarke.
4255 APPARATUS for COMPRESSING and CONSOLIDATING SCRAP METAL into BLOCKS and SLABS. T Sharp.
4267 ELECTRO-PLATING. T E Weatherall.
4283 "TWO-JAWED CHUCKS." J B Clive.
4291 BALL and ROLLER BEARINGS. F Dumoulin.
4293 SAFETY LOCK for GOODS WAGONS.* G Vogt.
4295 STEERING GEAR.* J Scott.
4298 APPARATUS for GALVANISING SHEET METAL. J V Laguesse.
4299 OPERATING RAILWAY SWITCHES. W E Brown.
4302 WELDLESS CHAINS. H Rougier.
4303 INSTRUMENT for SOLVING PROBLEMS in SPHERICAL TRIGONOMETRY. J Bogle.

28th February, 1893

4309 METHOD of SECURING the BOTTOM PART (or OIL RESERVOIR) to the TOP PART (or FRAME) of a SAFETY LAMP for USE in MINES. J E Robertson.
4310 ZINC OXIDES. A Gray.
4313 STEAM GENERATOR FURNACES. A Beldam.
4315 BAG FILTERING APPARATUS. M Blake and J Barclay
4317 LARGE STEEL PUNCHES. G Kynock and Co. Limited and E Jones.
4320 SHEARS for CUTTING SHEET METAL. J Watt.
4327 ADMISSION VALVE for GAS or OIL ENGINES.* W E Heys. (*R Langensiepen*, Germany.)
4330 COUPLING JOINTS for COUPLINGS of ELECTRIC MAINS. H W Bowden.
4331 MEANS for CONSUMING SMOKE and ECONOMISING FUEL. D France.
4333 APPARATUS for COMPENSATING the EXPANSION or CONTRACTION of RAILWAY SIGNAL WIRES. H McCarten.
4334 BRANCH-PIPE HOLDERS. J C Hudson.
4335 FILE-CUTTING MACHINES.* W Handley.
4341 WOOD SCREW. W J Taylor.
4344 EXPANSION and REVERSING GEARS for LOCOMOTIVES. F W Webb.
4345 SELF-ACTING DRAW-OFF REGULATOR. E J Whitlock and S Smale.
4352 ROTARY PUMPS. J W Holland and W E H Hollis.
4356 WELDING METALS ELECTRICALLY.* W P Thompson. (*C L Coffin*, United States.)
4358 FLUX or FLUXES for USE in SOLDERING ALUMINIUM and OTHER METALS. W P Thompson. (*U Nicolai*, Germany.)
4360 PLATES for ACCUMULATORS or SECONDARY BATTERIES. W P Thompson. (*La Société Electric Phœbus*, France.)
4362 AXLE BOX.* H Schubert.
4363 ELECTRIC RAILWAYS.* W P Thompson. (*J H Bates*, United States.)
4366 NUT LOCK.* G Gibson.
4367 NUT LOCK.* G Gibson.
4368 ELECTRIC ARC LAMPS.* B B Ward.
4369 COMBINED FLAME and INCANDESCENT LAMP. F Siemens.
4375 STREET-SWEEPING MACHINES.* F C Williams.
4376 AGITATORS.* R Smith.
4387 ANEROID BAROMETERS. E Whymper and J J Hicks.
4390 ELECTRIC ARC LAMPS. E Cannevel.
4393 ROLLING of RIBBED PLATES. C Löhr.
4407 NON-CONDUCTING COVERINGS for PIPES. P A Chabert.
4409 TRAMWAY SYSTEMS. M H Smith and J E Compton-Bracebridge.
4416 DYNAMO ELECTRIC MACHINE. D Fé y Fernandez.
4417 MACHINERY for BRONZING, COLOURING, and ORNAMENTING PAPER or OTHER MATERIAL in SHEETS or CONTINUOUS ROLLS.* J Bromley.

1st March, 1893.

4421 CENTRIFUGAL HYDRO-EXTRACTORS. G W Elliott.
4425 IMPROVEMENTS APPLICABLE to GAS and ELECTRIC LAMPS for AUTOMATICALLY TURNING the LIGHT UP and DOWN. T Gill.
4438 MACHINE for CUTTING TEETH in SPIRAL WHEELS. J Lang, jun., and R Lang.
4441 DOUBLE-ACTING FORCE PUMP. W H Knight and G A Morgan.
4453 IRON or STEEL TUBES or TUBULAR ARTICLES. A H Williams.
4454 BOLTS. C F Kite and W C Barns.
4455 VALVE GEAR for STEAM ENGINES. W D Grimshaw.
4465 FLUID MOTORS and PUMPS. J Farquharson.
4489 ELECTRIC FIRE ALARMS.* E C C Krogh.
4500 T and SET SQUARES. A F and S E Franklin.
4502 LUBRICATOR. F Tongue.
4503 GAS ENGINES and PISTONS THEREOF. W Triebel and E Heinrichs.
4511 PRESSURE GAUGES. J Jackson and E A Hoad.
4512 IMPROVED MOTOR. M W Lowinsky.
4513 PIPES or TUBES. F J Clinch-Jones.
4521 SPEED REGULATORS for the GOVERNORS or CUT-OFF MOTIONS of STEAM ENGINES. R Blezard and J G Herod.
4522 FEEDING DEVICES for ORES and OTHER MATERIALS APPLICABLE to STAMP BATTERIES. J B Sammels.
4523 STEAM GENERATORS, EVAPORATORS, and LIQUID HEATERS.* R Lederer.

2nd March, 1893.

4527 FRAMING or STRETCHERS for CORRUGATED IRON or STEEL SHEETING and ROOFING. W Thompson.
4541 APPARATUS for TURNING ENGINES OVER THEIR CENTRES WHEN COMBINED WITH "ROOTS BLOWERS." A D Ellis.
4546 STEPPED PILLARS or STANDARDS for CARRYING ELECTRIC LIGHTS, WIRE, and the LIKE. J B Millar.
4551 CHANNELLED or TROUGHED IRON or STEEL. P Robinson.
4561 GAS and SIMILAR MOTOR ENGINES. A R Bellamy.
4583 OIL MOTOR ENGINES. H P Holt.
4589 AEROPLANES or APPARATUS for AERIAL NAVIGATION. J O O'Brien. (*M H Rumpf*, France.)
4595 MOTORS. F Mitchell.
4608 CAR COUPLING. C H Carpenter.
4611 LOCKED NUT and BOLT. P H Russ.
4615 GRIP VICES. R G Fiège.

3rd March, 1893.

4618 ACTUATING CORLISS VALVES for STEAM ENGINES. R Brown.
4628 GAS, PETROLEUM, and LIKE ENGINES. D Clerk and F W Lanchester.
4636 FIREGRATES for FURNACES for STEAM BOILERS. H T Grundy and W Critchley.
4647 HAND-STEERING GEAR. R T Napier and A R Brown.
4650 VERTICAL STEAM BOILERS.* J Partington.
4651 CONSTRUCTION of STEAM BOILERS for and the METHOD of APPLYING FORCED DRAUGHT.* J Partington.
4652 LOCK or JAM NUTS. J M Stratton.
4656 APPARATUS for PREVENTING the FREEZING of WATER in the "CUPS" or "LUTES" of GAS HOLDERS. T D Archer.
4660 APPARATUS for EFFECTING the AUTOMATIC SAFE and REGULAR DETONATION of EXPLOSIVE FOG SIGNALS, PARTICULARLY APPLICABLE to LIGHTHOUSES, LIGHTSHIPS, ETC. F W Slaughter.
4661 STEAM or OTHER FLUID-PRESSURE ENGINES. S H Hollands.
4665 SUPPORTS or BEARINGS for OPERATING RODS of SIGNALS and SWITCHES. A G Evans.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to SIR H. READER LACK, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

All who are practically engaged in Mechanical Engineering or Scientific Industries are invited to avail themselves of THE MECHANICAL WORLD columns for information. We are glad to help the diffident, and, so far as we can, remove the obstacles which frequently prevent practical men from communicating their ideas.

We wish it to be distinctly understood that we cannot, for any consideration, and will not knowingly, allow our editorial columns to become the vehicle for mere advertisements of machinery, apparatus, or anything that falls within our province to notice.

Every correspondent should forward his name and address, not necessarily for publication unless so desired. We do not undertake to return MSS. unless specially requested, and in such cases stamps should always be sent.

All communications relating to editorial matters should be addressed to the Editor of THE MECHANICAL WORLD, at the Manchester, and not the London, Offices.

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☞ Owing to the large demand for back numbers of THE MECHANICAL WORLD, we are compelled to fix the following scale of prices:—Copies published in 1887, 6d. each; 1888, 5d.; 1889, 4d.; 1890, 3d.; 1891 and first half of 1892, 2d. each.

All remittances payable to EMMOTT AND COMPANY LIMITED, Publishers, either at New Bridge Street, Manchester, or 85, Strand, London, W.C.

FACTS FOR ADVERTISERS.

A TON AND A HALF OF PAPER is now used every week in the production of THE MECHANICAL WORLD, three-quarters of a ton being despatched to the London Office (85, Strand) for distribution throughout the Metropolis, the Southern and Home Counties, Ireland and abroad, by the London wholesale newsagents. The other three-quarters of a ton are similarly distributed throughout the Midland and Northern Counties, Scotland, and Wales.

☞ *THE MECHANICAL WORLD is published every Friday at 85, Strand, London, and at New Bridge Street, Manchester. It is particularly requested that business communications from the Provinces be addressed to the Offices at New Bridge Street, Manchester, and London communications to 85, Strand. Letters referring to Editorial matters should in every instance be sent to the Manchester Office.*

FRIDAY, MARCH 24TH, 1893.

A Manufacturing Company (?)

A FEW weeks ago reference was made to the policy followed by some, presumably, electrical companies in devoting a great deal of attention to the promotion of subsidiary companies rather than carrying on a purely manufacturing business. We then instanced two or three cases, one of which has been greatly aggravated by the investigation of its affairs by a committee appointed at a meeting of the shareholders. We refer to Woodhouse and Rawson United Limited. After the report of the committee of investigation which was recently presented, and which showed that the profits made were paper profits, that the dividends of 15 per cent. on the ordinary shares paid by the company for two years were paid out of capital, and that the assets were of little value comparatively, a receiver is put in possession on the application of a debenture holder. Then came the directors' reply, and now on Monday last the shareholders resolved unanimously to liquidate the company. The whole of the money furnished by the preference and ordinary shareholders has gone, and some of the holders expressed the opinion that the directors were legally liable to proceedings for the present position of the company. The Kidsgrove works are described as a country boiler shop, which, although put down at some £40,000, are not worth much more than the price of old iron. The shareholders on Monday were angry, and justly so. They have, excluding the holders of debentures and debenture stock, practically lost the whole of their money, and it was only by resolving to voluntarily liquidate the company that there may be a possibility of recovering a little; whilst in the event of a compulsory winding up, everything would have been lost. The formation of subsidiary companies to work patents has been a bad thing for Woodhouse and Rawson United Limited, and still worse for the effect it will have upon the public. The disclosures hitherto made reflect very strongly upon the directors, and as far as could be ascertained from the lengthy proceedings on Monday legal action may be taken in the matter.

Signalling to Balloons.

IN a recent issue mention was made of the system devised by Mr. Bruce for transmitting signals by electricity to balloons, according to the Morse or any other code. The priority of this invention is claimed by Chief-Lieutenant Buchholtz, of the Prussian Army, for the late Mr. C. Frischen, who as long ago as 1885 is said to have carried out experiments on that system. The tests were made at the telegraph works of Messrs. Siemens and Halske, in Charlottenburg, with a spherical balloon of 20ft. diameter, and in the centre of which was placed an incandescent electric lamp of 50C.P., which in the distance resembled the rising moon. The signals were transmitted by a Morse instrument, and enabled communication to be made to some distance. It would be interesting to know whether this is a case of history repeating itself, or whether Mr. Bruce had any knowledge of Mr. Frischen's experiments.

International Exhibition at Lyons.

IT is intended to hold an international industrial exhibition at Lyons next year, from the 26th April to the 1st November. Bearing in mind the Paris Exhibition of 1889, the promoters of the Lyons show have decided that it would be difficult in that town to organise an interesting display without proceeding on lines differing from those followed at Paris. It is therefore proposed to construct a main building at the Park of the Tête d'Or of a superficial area of 50,000 metres, and of a polygonal form, with the exhibits so arranged as to be all seen by visitors. There will be slow-travelling platforms, located on galleries, for the transport of passengers, and a large dome in the centre of the building at a height of some 150ft., lighted by electricity, will assist in the expulsion of the vitiated atmosphere, the fresh air entering at the periphery of the structure. The offices of the Commissariat Général are at 46, Boulevard Haussman, Paris, and applications from intending exhibitors must reach there before the end of next October.

The Niagara Falls.

SOME time ago we referred to the work being undertaken in connection with the utilisation of a portion of Niagara Falls for the production of electrical energy for lighting and motive-power purposes, and to the forthcoming completion of the undertaking. Professor G. Forbes, a well-known English electrical engineer, and who is connected with the Cataract Construction Company, who are carrying out the work, is now in the States, where in the course of an interview he gives some information concerning the present position of the enterprise. It appears that the hydraulic portion of the scheme has been completed—that is, the canal, tunnel and the erection of the vertical turbines,—whilst contracts for the electrical plant are now being entered into. It is intended to use the alternating-current system for distribution in Buffalo, and either the same or the continuous-current method for local supply. The current will be sent out at 20,000 volts, using for Buffalo step-up transformers for transmission, and step-down converters for distribution. Each turbine is capable of yielding 5000H.P., and the twenty turbines to be used will give a total of 100,000H.P. Already numerous applications have been made for electrical energy for power purposes, and Professor Forbes states that the power will cost consumers much less than that obtained from steam plants, that being, therefore, an extra inducement to take up a supply. The tunnel is 6700ft. long, and the canal which feeds it is 500ft. wide and 1500ft. long. The inclination of the tunnel is 7ft. in 1000ft., the velocity of the water being 25ft. a second, the stream issuing from under the suspension bridge. In addition to this, the company have the right of way for a parallel fall for another 100,000H.P., and a concession for the Canadian side for another tunnel. Professor Unwin is preparing plans, and with that tunnel it will doubtless be possible to obtain an additional 250,000H.P. The undertaking promises to be a big thing. Let us hope it will be a success.

The Condition of the Engineering Trades.

JUDGING from the reports issued for the past month by the trades union organisations connected with the engineering trades, there are signs of a distinct improvement taking place in the condition of these industries. So far as regards the number of men unemployed, it may be said that in the Amalgamated Society of Engineers the number of members now receiving out-of-work support has fallen to about 8 per cent. of the total membership, while in the Steam Engine Makers' Society there has been a reduction of quite 1 per cent. during the past month in the number of members receiving out-of-work support, and there are now barely 4½ per cent. of the total number of members on the books in receipt of donation benefit. In the Tyne and Wear districts, however, all the artisans engaged in the engineering trades on the two rivers have received notice from the masters of a reduction in wages, to take effect in May next. The decrease which the employers ask is 10 per cent. on all wages exceeding 20s. per week, and 5 per cent. on wages of 20s. or less. The notice also affects the operatives in the boiler yards connected with the engineering establishments. Altogether about 15,000 men have received notice.

The Protection of Smoke Makers.

OUR American cousins are nothing if not original, and the latest evidence of this is to be found in the formation of a society for the protection of smoke makers. We have on previous occasions referred to the strenuous efforts which are being made by the authorities in Chicago to suppress the smoke nuisance, and it appears that one of the results of the crusade has been the organisation of a society for the purpose of fighting the efforts of the Society for the Prevention of Smoke. Quite a number of manufacturers have joined this new association, and these are supported by some of the bituminous coal-merchants, who believe that their commodity is suffering unjust treatment at the hands of the society's agents. An address has been issued by the "smoke makers," which states that they have been unable to find economical and efficient devices for the complete combustion of bituminous coal. This, however, has called forth quite unexpectedly a most gratifying expression of opinion from other manufacturers, who state that they are using apparatus for the prevention of smoke which they have found both satisfactory and economical, so that the case for the smoke makers appears to have altogether gone to the wall.

Gas versus Electric Motors.

IT rarely happens that gas motors are brought into competition with electric motors for the working of tramways, but such is now the case at Erfurt. The representatives of the Thomson-Houston Company have approached the municipality with a view to the granting of a concession for the laying down of an electric tramway on the trolley system, the existing horse tramway company being prepared to liquidate if the grant is made. The municipality is disposed to entertain the proposal, especially as it is intended to extend the tramway system. On the other hand, a Dessau company offer to work the tramway service by means of cars driven by gas motors, which have already experimentally given good results in Dresden, with the advantage of its not being necessary to use overhead wires. A decision has not been arrived at, but the municipality has appointed a commission to investigate the matter. Gas motors have only to a very slight extent been adopted for tramway work, and that, too, in the United States. Probably the type which has been introduced the most is the Connelly motor, to which we referred some time ago, and which is now being tested on a small section of the London and Greenwich tramway system. There may be a future for oil motors for operating tramcars, but they have not yet reached the efficiency of electric cars operated on the trolley system. There is ample room for all, and each method deserves a fair trial.

Hull and District Institution of Engineers and Naval Architects.

ON Monday evening, the 13th inst., the members of the above institution held their usual monthly meeting at the Institution Rooms, Bond-street. The lecturer for the evening was A. H. Bate, Esq., A.I.E.E. (of Messrs. Edison and Swan Limited), the title of his paper being "Some Notes on the Electric Lighting of Ships." At the commencement of his paper the lecturer reverted to the time when (thirteen years ago) Mr. Swan and Mr. Edison invented the incandescent lamp. Then, probably, no sober-minded man would have believed that in a single decade that tiny toy, shown occasionally at popular lectures, would become an important article of commerce and create an industry more vital to our civilised life than the telegraph or telephone.

That the cool healthy light of the incandescent lamp met with such a favourable reception shows that it supplied a public want; but in the early days there were serious defects, the lamps flickering and breaking, and too often the machinery broke down and the lights were extinguished. One by one, however, the difficulties have been overcome and improvements made, till now the uncertainty which at one time threatened the electric light with public disfavour is almost unknown.

Mr. Bate stated that there are few electric-light installations which can be carried out under such favourable conditions as obtained on shipboard. There is no objection to noise and vibration, the lights are all near the dynamo, and do not require great lengths of expensive copper wire, etc. (as on shore); and, above all, the steam power is already at hand, and can be used without any sensible difference in the coal bill—the power required for the electric-light plant in comparison with the usual steam power being only about a half per cent. in first-class war boats, and not more than one per cent. of the indicated horse-power for ocean liners.

The different classes of engines and dynamos were dealt with, the lecturer advising that dynamos of a standard pattern by some large maker should be used, so that in case of a breakdown of the armature, a new one could be supplied at once from stock whilst the steamer is in port; he also advised that the dynamos should be "compound wound"—that is, so made that if part of the lamps be switched off, the remainder, if the engine is properly governed (and the best of governors should always be used), would not burn more brightly or get over-heated and so practically spoilt.

Mr. Bate then dealt in a most comprehensive manner with the best methods of grouping lamps on the different mains, according to their uses, the switchboard attachment, fuses, cut-outs, the best forms of wiring (both the single and double-wire system being explained), insulating materials and sheathing joints, the most economical and suitable voltage at which to run the lamps, the construction of the various lamps, fittings, etc., etc., and also explained a simple and effective device for finding and locating any leak or defect in the insulation.

The lecture was illustrated by diagrams and samples of lamps, switches, cut-outs, etc., etc., chief among the exhibits being one of the new electric miners' lamps, charged and working, and a voltmeter or electrical pressure gauge.

Machine Construction.

THE CONSTRUCTION OF MACHINE ELEMENTS.

(Continued from page 82.)

IN Fig. 449 is shown the cylinder friction clutch of Koechlin. In this case the clutch movement takes place radially. The part A is a hollow cylinder in which three internal clamp pieces are fitted, each being provided with a bronze shoe. These are thrown in and out of action by means of a sliding collar B′, which operates right and left-hand screws by means of the lever b. The clamps slide in radial grooves, and

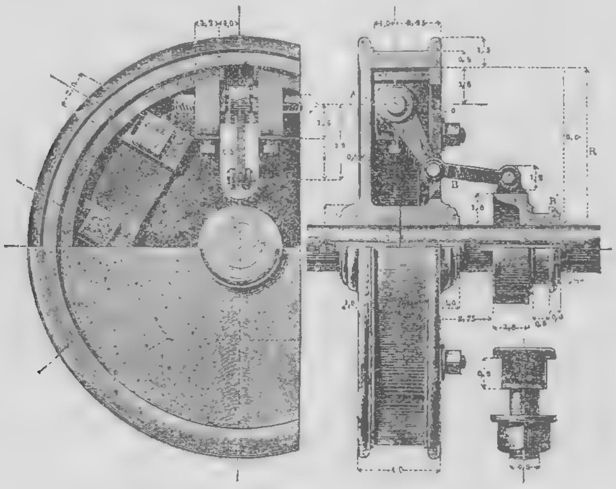


FIG. 449.

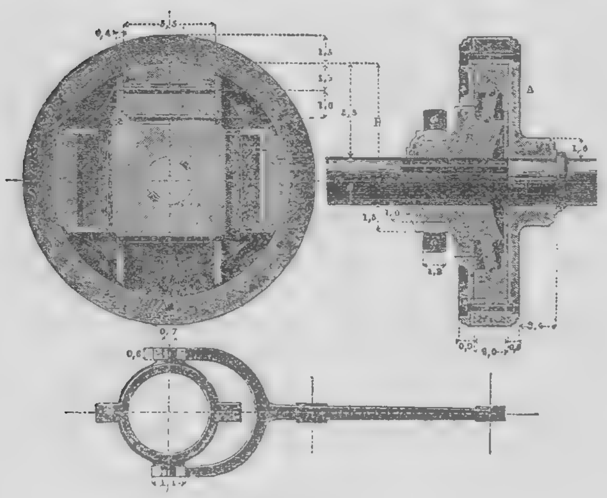


FIG. 450.

the details are fully shown in the illustration. The nuts for the right and left-hand screws can be closely adjusted and clamped by set screws, so that a radial movement of less than $\frac{1}{16}$in. is sufficient. There is no danger of wedging the parts fast in this form of clutch, as may be the case in cone clutches, as the elastic reaction of the cylinder assists in the direction to release the parts. At the same time the screws prevent the coupling from releasing itself, and the axial pressure Q upon the collar B′ can be transmitted so that the screws need not have too quick a pitch.

If s is the pitch, b the length of lever arm, f the coefficient of friction of the clamping pieces, we have for the transmission of a given moment (P R), neglecting the friction of the screws,

$$\frac{2s}{2\pi b} \frac{P}{f} \text{ or } Q = \frac{s}{\pi b} \frac{PR}{fR} \ldots\ldots (147)$$

which gives a very small value for Q.

R. The modulus is the same as before :—

$$\delta = \frac{d}{3} + \frac{3\text{in.}}{16}.$$

A very excellent form of this coupling was designed by Bodmer, independently of Koechlin,† and a similar arrangement has been adapted to mill gearing with success.‡

Cylinder couplings in which the clamping pieces are operated by toggle joints are also made. An example is shown in Fig. 450, which is a clutch by Fossey, as applied to mint machinery.§ This is a very compact design and is arranged with four clamps, which have no bronze shoes.

The toggle links are as wide as the clamps, and are fitted with half-journals to transmit the pressure outwards, while to draw the clamps back, light through bolts are used (see § 95). If the toggle links make with the axis an angle of $90° + a$, we have for the axial collar pressure :—

$$Q = \frac{P \tan a}{f} = \frac{P R}{R} \frac{\tan a}{f} \ldots\ldots (148)$$

The angle a may be taken very small, since there is no danger of clamping. The value may be as small as a 2°, or even 1°.

For $a = 1\frac{3}{4}°$ we have $\frac{Q}{P} = \frac{0{\cdot}03}{0{\cdot}15} = \frac{1}{5}$.

Another form of cylinder coupling using toggle levers has been designed by Gerand.‖ Jackson uses hydraulic pressure to force the clamps into contact.¶ Dohmen-Leblanc uses springs to throw the toggles out of action.** Schurmann uses, instead

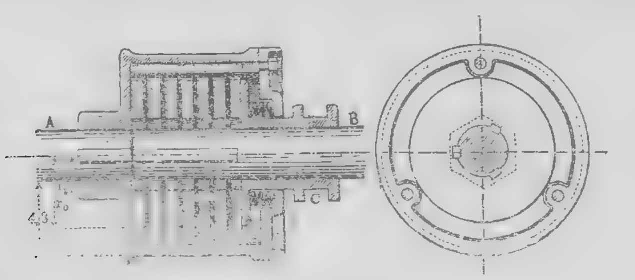


FIG. 451.

If the parts are so arranged that B is the driven part, there will be no collar friction at B′ when the coupling is not in action. When the shaft is vertical a weight may be used instead of a collar and lever, and by gradually lowering it the apparatus may be started with very little shock. The first clutch made by Koechlin was designed for the transmission of 30H.P.* The above value corresponds to a minimum value of

of the separate clamps, a ring, which is compressed externally; Napier also uses a ring, expanded from within.†† Becker

arranges the clamp blocks to be operated by centrifugal force.‡‡ These are only a few of various modifications of the cylinder coupling.

A form of axial friction coupling which acts with very slight pressure is the Weston clutch, made by Tangye.§§ This acts upon the principle of multiple plate friction (see § 101), as is shown in Fig. 451.

The wooden discs are engaged with the case, and the iron ones with the shaft. In the form shown the plates are pressed together by the springs, and released by drawing back the collar B and releasing the spring pressure. A larger example of Weston's clutch is shown in Fig. 452. A is a winding drum, B the shaft driven by the engine. The outer disc C and the inner discs of the coupling are held apart by spiral springs, as show at a. A light pull

friction bands b_1, b_2 slip upon B, being able to move no faster than A. When the speed of A increases and gains upon B, the pawls are again thrown into gear and A is automatically coupled to the shaft. In order that the pawls may not bind upon the ratchet teeth in releasing it is necessary that the angle γ, which the pawl makes with the face of the ratchet tooth, must be less than the complement of the angle of friction; in this case $\gamma = 60°$. Pouyer uses only one friction band and makes both pawls engage at the same time. In the illustration the ratchet wheel is made with an odd number of teeth (13), and the pawls are placed so that a movement of only half the pitch will cause the parts to become engaged. The above proportion of the angle of the teeth is of importance, as otherwise the points of the teeth are apt to be broken.

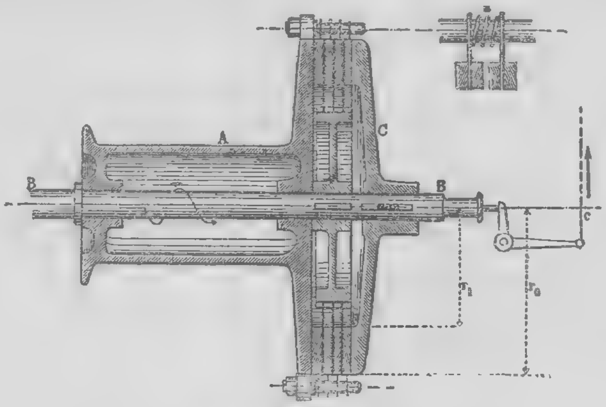


FIG. 452.

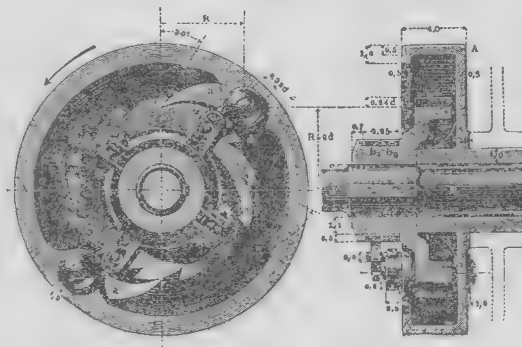


FIG. 453

on the cord c holds the drum stationary; a strong pull engages the clutch for winding; if the cord is left slack the load on the drum runs backward.

158.

AUTOMATIC COUPLING.

When power is transmitted to a shaft from two different sources, as from two independent engines, it is desirable to have one or both of them connected by a coupling which will automatically release or engage with the shaft, according to the distribution of the work. If one motor tends to overrun it will then be given more of the work, and so the resistance will be equalised. Such a device is the coupling of Pouyer-Quertier, generally known as Pouyer's coupling.

This is shown in Fig. 453. In this case the parts are so disposed that the part A, which is driven by one source of motive

The pawls, also, should be of hardened steel.

In Germany, Uhlhorn's coupling is used for similar service, as shown in Fig. 454. Here A is the part connected to the motor, and B is fast to the driven shaft. A is an internal ratchet wheel into which the pawls b enter. The springs a serve to ensure the entrance of the pawls into the teeth, which engagement continues so long as a drives B. If the speed of A is retarded, the pawls are retracted as shown in the lower part of the figure. In this case the springs act to keep them out of gear, being the reverse action to that of an ordinary ratchet gear.

The pawls are fitted with half-journals (see § 95), and are held in place by a plate ring, as shown. Uhlhorn originally used only two ratchet teeth in A, but increased the number afterwards to four, so that the parts would engage in a movement of

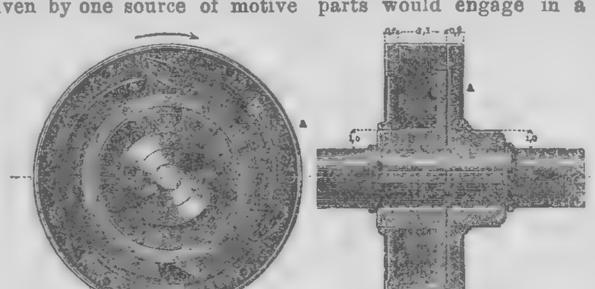


FIG. 454.

power, is loose on the shaft B. This part A may have gear teeth upon its circumference, for example, or may have a gear wheel mounted upon its hub, as shown by the dotted lines; the hub being bushed with bronze. Upon the shaft B a ratchet wheel is keyed; the pawls a a, being upon A, engage with the teeth when A drives B, but if B gains upon A, or A stops while B continues to move, the pawls are thrown out of action. The direction of motion is shown by the arrow. The pawls are released by the action of the friction bands b_1 and b_2, which are carried forward by friction upon B, whenever B gains upon A, the levers b throwing the pawls a out of gear. As soon as the limit of travel of the levers b, b is reached, the

one-fourth a revolution. It is better to use an odd number, as three, and by proper spacing of the pawls the greatest play will be one-half a space, or one-sixth a revolution with three teeth, as in the case of Pouyer's couplings. B may be the driving part instead of the driven; but, in that case, the direction of the arrow must be reversed.

(To be continued.)

The Building Exhibition.

THIS exhibition, which closes to-morrow, at the Agricultural Hall, Islington, N, does not belie its name, being fairly representative of the building and kindred trades. Most, if not all of the exhibits are practically beyond the scope of this journal, and we have therefore not devoted

* "Bulletin von Mülhausen," 1854, p. 138.

† See Fairbairn, "Mills and Millwork," vol. ii., p. 92.
‡ See Uhland's "Prakt. Masb. Konstrukteur," 1869, p. 97.
§ See Armengaud's "Publ. Industrielle," vol. xvii., pl. 10.
‖ "Dingler's Polyt. Journal," vol. 149, p. 22.
¶ Ibid., vol. 153, p. 251.
** German Patent 16,952.
†† "Engineer," 1868, July, p. 64.

‡‡ German Patent 7205.
§§ In the U.S. by the Yale and Towne Manufacturing Company.

space to their consideration. There is, nevertheless, much of interest to architects, builders, municipal engineers, and others, who will find that the cheap-jack order of exhibitor has been almost entirely excluded. There are present two or three gas engine firms who make a display at all shows held in the hall, one well-known maker of steam engines, and an oil engine recently brought out in this country. With these exceptions, the other exhibits particularly refer to the building trades, and some of them are of special interest. Fireproof flooring, for instance, is in strong competition, and attracts considerable attention. The exhibition is well worth a visit.

The Under-type Stationary Engine.—XXV.

LEVER and weight safety valves are perhaps more generally used than is wise, as they are very liable to be tampered with. We shall only illustrate one example to point out its special features. Fig. 54 shows a lever and weight safety valve as introduced by Professor J. Klotz, of Prague. "It consists, first, of a seating that is not used to contain the movable part of the valve as in the ordinary safety valve, but merely to fix the valve in its place, and to form the base of its superstructure, and to supply a passage for the escaping steam. Secondly, of a hollow cylindrical part, which is raised above this seating, and attached to it by feathers, and forms the guide to the movable part of the valve. Thirdly, of a movable part fitting outside of this cylindrical part. The cylindrical part is closed in the centre to all except a pipe to be hereafter described; also the movable part is closed at the top as usual, and there receives its load. Here is a radical departure from all previous constructions of safety valves, and the movable part is not actuated by the escaping steam, but by the full pressure of steam within the boiler, specially conveyed to it by means of a pipe screwed into the solid centre of the cylindrical part. Thus the most important principles of construction are embodied in this valve. The lever, constructed with knife edges, or in steelyard fashion, instead of with joints and pins, constitutes a great improvement, as there is no liability in them to stick fast, while there is much greater accuracy of leverage and much less friction. The strut being made in the form of a simple pin with rounded ends, ensures the load being put evenly on the valve at whatever angle the lever may be standing."*

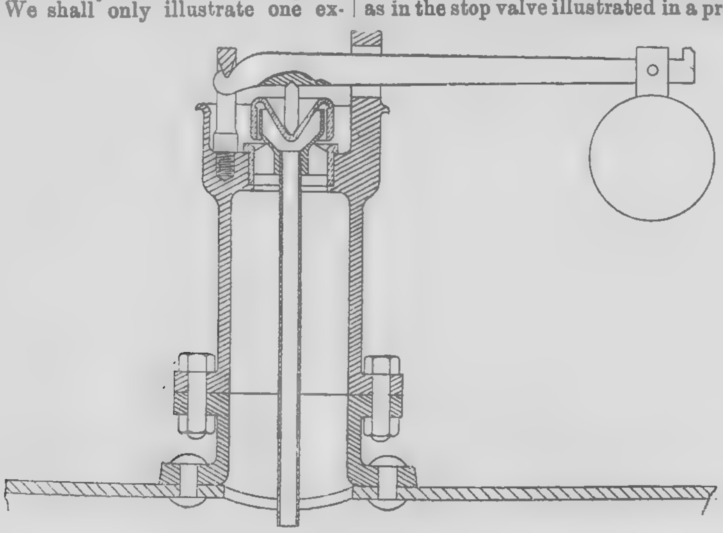


FIG. 54.

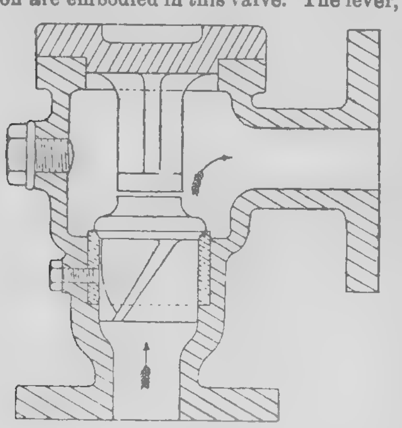


FIG. 55.

On every locomotive boiler there should be a Ramsbottom safety valve, and as a second valve a deadweight Hopkinson valve, or a closed lever and weight safety valve. The latter is easily contrived. The closed lever valve should be weighted lighter than the open spring valve, and should extra weight be put on the lever valve by the man in charge, the spring valve would blow off first, and thus act as a tell-tale.

Fig. 55 shows one form of clack valve suitable for bolting to the front or on to the barrel of the boiler. In this instance the shell is cast iron, the seat and spiral-wing valve are made of brass, and the top cover is of elliptical form, and held down by two bolts and nuts. A cleaning-out plug is shown opposite the inlet into the boiler, and the valve seat is held in position by means of a small screw; a hole is often drilled into the top of the valve and tapped, so that a suitably screwed tool may be used to lift the valve out. When a battery of boilers is fed from one main, it is necessary to have check valves with outside screws and hand-wheels, so as to regulate the lift of the valve or to shut the feed off altogether when required. The lid is then made circular, and the details are worked out the same as in the stop valve illustrated in a previous article, except that the spindle is separate from the valve, and has a collar cast on the end which forms a buffer for the valve. Locomotive boilers are often equipped with duplicate feed arrangements, a separate donkey pump or an injector being used in addition to the pump on the engine. Instead of supplying an extra check valve, the two valves may be neatly combined in one casing with one common inlet into the boiler, thereby saving a second fixing on the boiler barrel. When the check valve is placed on the front of the boiler, it is usual to provide an inside feed pipe, which is of the same diameter as the feed inlet, and sufficiently long to conduct the water beyond the firebox; this feed pipe has the end blocked up, and a number of holes are drilled and placed in such a position that the feed water does not impinge on any heated parts of the boiler, but is spread towards the outside plate of the barrel. The feed pipe is placed on the lowest water line; the flanges of the check valve and the feed pipe are held up to the front plate by the same bolts.

When required, a scum cock is placed on the boiler front in the same position as the clack valve, but on the opposite side. This cock may be of Hopkinson's make, with compound gland, asbestos packed. Bell's Asbestos Company make a very suitable cock for this purpose also.

The blow-off cock must be of the most reliable kind, as many serious accidents have occurred from the use of defective cocks. The ordinary cock is liable to become leaky, owing to the grinding action of the sediment on the plug when in use.

And as these cocks are out of sight, a leakage is not easily detected. Blow-off cocks with screwed plugs are never used, gland cocks having taken their place; but even these are not considered satisfactory, so now the plugs are packed with glands of the compound type. In THE MECHANICAL WORLD for 4th May, 1889, a good form of blow-off cock is shown, which is designed to prevent the scale or gritty sediment from injuring the plug through the frequent opening or closing of the cock.

(*To be continued.*)

* Safety Valves," by Mr. John C. Wilson.

THE official eight hours full-power natural-draught trial of the new first-class torpedo gunboat "Jaseur," built and engined by the Naval Construction and Armaments Company, Barrow, took place at the mouth of the Thames on the 14th inst., under the superintendence of the officials of Sheerness Dockyard and the Medway Steam Reserve. The trial was attended with successful results, the engines working 220 revolutions per minute and developing 2545·8H.P., with a mean speed of 18 knots.

The Design and Erection of Flour Mills on the Roller System.—XXII.

THE use of white iron exclusively for chilled rollers would not give good results, as its brittle character would not give the requisite strengths; but by the process of chilling, grey irons are converted into white irons on their surface, the interior of the casting still retaining its grey colour, and the combination producing a stronger roll, whilst the carbon in the roll at the surface may be said to be in a chemically combined state, and not open to objection for the purpose of roller milling. The presence of sulphur has a decided tendency to raise the chill and to lower the transverse strength of the casting to an undesirable extent, so much so, in fact, as to render it useless.

If the iron of a given brand, or, say, from a given furnace, could be relied upon as certain to contain its carbon combined and mechanically diffused in uniform relations and quantities, while other impurities, as sulphur and phosphorus, were also constant in quantity, it would be possible to select one make of iron always suitable for the production of castings, with a requisite depth of chill; but this is not possible, as different brands and grades of iron vary from time to time in their chilling property.

Assuming that three or four brands of metal are used, these are broken up, then melted in a cupola and run into pigs. They are then broken, and remelted several times to obtain a thorough mixing of the metals used. As there is no chemical affinity between the irons of different brands, it is therefore next to impossible to obtain a perfectly homogeneous iron from a mixture of various brands by one melting alone. Firms that have a regular demand for rolls prepare their metal in this way. Finally they melt it in a cupola and run it into the moulds.

Melting and remelting cast iron increases the strength as well as the density. Mr. D. K. Clark, in his manual of "Rules and Tables for Mechanical Engineers," page 557, gives the result of an experiment where Eglinton No. 3 hot-blast iron was passed through 18 meltings. For the first melting the compressive strength was 44 tons, after the 18 meltings the compressive strength was 88 tons; but it appears that the tendency of remelting so many times leads to a gradual abstraction of the constituent carbon of the iron, and the approximation of the metal in composition to wrought iron. This shows that the more thorough mixings with the least number of meltings ought to give good chilling properties.

Ordinary good cast iron has been used for rolls without chilling, and the surface of such rolls presents a more natural grit; but the surface is not sufficiently hard to withstand the wear, and the carbon in the iron would not be in a combined state. Steel rolls are not found to be equal to properly chilled iron rolls, and, strange to say, chilled iron rolls acquire their best working surface when they have been a short time in use.

The following mixture of iron will give about 1in. depth of chill, such as required for rollers for flour mills:—

Hematite, No. 5	10 parts
Lilleshall, cold blast	8 ,,
Cleator, white	4 ,,
Brymbo	2½ ,,
Pontypool	4 ,,

A mixture for the same purpose which will give a chill from 2in. to 3in. is:—

Hematite (mottled)	1 part
Hematite, No, 5, strong	1 ,,
Blaenavon or Pontypool, cold blast	1 ,,

Another mixture for a chill ¾in. deep may be:—

Hematite, No. 5	5 parts
Lilleshall, cold blast	5 ,,
Cleator, white	4 ,,

For rollers of large drain, and requiring a chill from 2in. to 3in. deep, the following mixture will answer:—

Cleator, white	4 parts
Brymbo	½ ,,
Lilleshall, cold blast	8 ,,
Hematite, No. 3	6 ,,
Pontypool, No. 3	1 ,,

The reader will understand that the given mixtures apply to chilled cast-iron rollers only. The mixtures vary for different castings. Thus, for example, heavy wagon wheels cast on a chill require about ¾in. depth of chill, and the following mixture may be used:—

Blaenaven or Pontypool	1 part
Cleator or Brymbo	1 ,,
Hematite, No. 5	1 ,,
Selected scrap	2 ,,

We will now consider another, if not the most important matter, relating to process of chilling castings—viz, the "chill," or chilled mould. There are a number of engineers who suppose that the thickness or weight of a chilled mould affects the greater or less depth of the chill, but practical everyday experience teaches us different. It is a huge mistake to suppose that great thickness of the chill mould will produce a deep chill; on the contrary, it will act injuriously, by carrying off the heat from the chilled surface at a rate which is so much greater than that at which it is carried off from other parts of the casting thus differential strains are set up which often as not cause a rupture. The safe rule to work by when designing a chill mould is to make the chill about the same weight as the casting, as a large quantity of heat is rapidly carried off by the surrounding air from the chilled mould. Of course, a less weight than this would produce a good chill; but it is not desirable to make very light chills. No one so far has advocated this.

The manufacture of chilled moulds is a costly work, as each chilled mould must be bored out accurately to the size of the roller to be cast. The "chills" are also liable to crack, and their durability is very uncertain. "Chills" are usually made of the best cold blast iron of close texture, *but the metal that will make a good roll will make a good chill.* It is also good practice to shrink wrought-iron bands around the chilled mould, and better still to cast, say, three wrought-iron rings in the mould. The best and strongest casting and the finest chill can always be obtained when the iron is poured immediately after ebullition has ceased and the metal becomes quiet in the ladle. It is also most important *that the chill mould should be warmed*, say for 48 hours, in the core-drying stove. If this is not done it is quite possible that the chill mould will part asunder, and if this does not occur the casting will only have a shallow chill, so intense as to make the roll useless, for no tools will cut it.

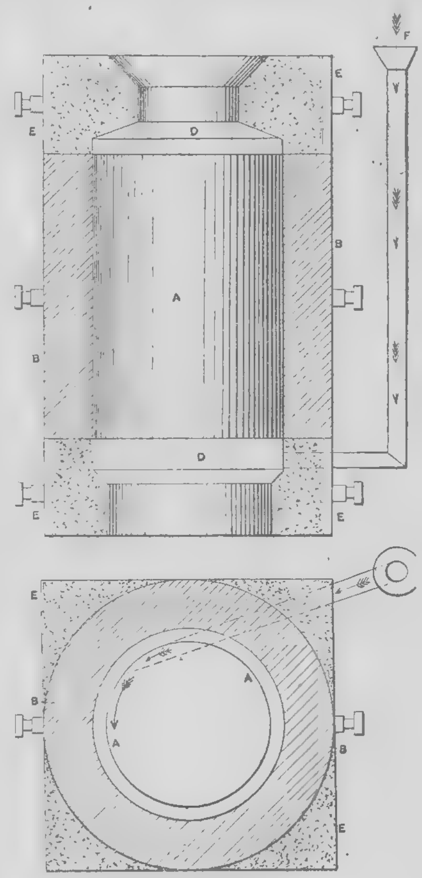


FIG. 23.

Fig. 23 shows the arrangement for casting a chilled roller, which is self-explanatory. A is the roller as cast in the chilled mould; B the chilled mould, warmed to a temperature of from 150° to 200°; D parts of roller to be turned off; E top and bottom boxes, containing loam; F inlet for molten metal.

In pouring the metal it is desirable to admit the same into the mould as a tangent, so as to give a *rotary motion* in the mould (Fig. 23). By this means the scum and gases are assisted to rise to the top surface. The necessary rotation is less as the metal employed is more fluid; but too rapid rotation must be avoided, as this would wash away the fine coating of clay and black lead with which the chill is painted. In concluding these few notes on chilled iron rollers, the writer recommends the cupola in preference to the crucible for melting the iron.

(*To be continued.*)

Hints to Intending Seagoing Engineers.

[CONTRIBUTED.]

(Concluded from page 88.)

At last he gets the desired appointment and signs the ship's articles. A great deal depends upon whom he becomes associated with on this his maiden voyage, for although the machinery in the ship may be identically the same as that he may have been engaged on in the shops or the other ships of the company in the shore gang, he will find things very different at sea to what he would generally expect. He should make the best use of his spare time before sailing in getting acquainted with the engines and boilers as much as possible; and there are few chief engineers who, when they have a young beginner to train, and find him civil, attentive, and anxious to learn, will not always endeavour to put him in the right way of doing everything that is required, and check him when necessary. It is a great mistake to appear too big to be told anything, for the don't-want-to-be-told engineer generally gets himself disliked in a very short time. Orders should be promptly obeyed, even if they may appear somewhat unnecessary. The writer is aware that there are chief engineers who, by way of showing their authority, will unduly put upon the junior engineers; but it is better even in this case to "grin and bear it" than to kick against what may be unjust treatment. The only remedy in this case is to leave the ship when she arrives home again. It must not be understood from this that the writer advocates the young engineer leaving his ship after one voyage, for it is best to keep to one vessel, and it is highly creditable to have a good string of discharge notes from the same ship.

Our third will require to become familiar with the various valves and pipes leading to and from the different parts of the ship, to the pumps, and overboard. He should trace them as far as possible, and when in doubt it is far better to make inquiries before opening or closing any connection with which he is not acquainted than to run the risk of bursting some of the pipes or spoiling the cargo by letting water into the holds.

When preparing to sail and working the ship out of the docks, the third should always be in the engine room, as extra attention is required at such times, and there is generally plenty of work for all. He must not be afraid of working a few hours extra, as he will be well repaid before he reaches home again, for there is nothing which cultivates harmony and respect amongst engineers more than each one trying to do his best. When going on watch he should always make it a point of being punctual, for the engineer going off duty is very anxious to get a breath of fresh air after being below four hours, especially in hot weather. When he goes down into the engine room the first thing that should be attended to is the water level in the boilers. This being carefully noted, and the pressure of steam on the gauge, he should return to the engine room and feel round the working parts to ascertain if all is working properly and cool. It is best to fix upon a certain place to start at, say at the fore engine, and go round, finishing up at the stern gland in the tunnel. He should also make sure that the bilges are clear of water, and that the pumps are working properly. After having satisfied himself that everything is working all right, he can acquaint the retiring engineer to that effect, and he in turn will then inform him of any orders that may have been left, which should be duly entered on the log slate to make sure they are not forgotten; also if he (the retiring engineer) has had any trouble with any particular portion of the machinery, it is his duty to inform the man who relieves him, so that he may give that part a little more attention in case the same trouble may arise again.

During the entire watch all his thoughts and attention should be given solely to the care of the moving machinery entrusted for the time being to his care, and he should never, on any account, think of sitting down while on watch. The oiling should be performed with great regularity, and by cultivating a proper system of working it will save many hours of trouble and annoyance which would otherwise occur. A good look-out should be kept for nuts working loose, and any unusual noises that may occur should at once be detected, immediately acquainting the chief engineer of the fact. The expansion, throttle, stop, and injection valves should not be altered on any pretext without orders.

Should the telegraph ring, he should make a point of answering it in the first instance, and then proceed to carry out the instructions with despatch. At the same time he must keep cool and not get excited over it, or he will make some mistake. In the case of slowing down or stopping at sea without warning, the order must be given to the firemen to close all the dampers, in order to check, as much as possible, the generation of steam.

It is a great mistake to do any kind of work, such as filing, etc., at the vice when on duty, for when thus engaged time slips on and the oiling of the engines and water level in the boilers are neglected. The water-gauge glasses should be blown through about every hour to prevent them from getting choked up with sediment and indicating a false water level.

Our young engineer should always insist on order and cleanliness in the engine room. He should keep his position and dignity with the firemen, give orders straight to the point, and never argue with them as though he were asking favours of them instead of a right. No fireman should be allowed to alter any valves on any account, and above all, the engineer must not become too familiar with them. The pumping arrangements should be attended to, and the amount of water in the bilges noted from time to time. Waste or chips should never be allowed to be swept into the bilges, or this getting into the strums will necessitate an exploration of the lower regions.

When going off duty everything should be left in order, with oil feeders filled and hand lamps trimmed. Then, again, he should not contract the habit of loitering about in his dirt, but should get washed and change his clothes. He should spend his spare time profitably, endeavouring to increase his knowledge by studying some good engineering books, instead of wasting the time in card playing or yarning with some of the hands about deck. He will find the benefit of this course when he has spent the required time and presented himself for examination, for a good inspector will very soon discover whether his knowledge is real or artificial.

The sea-going engineer must be prepared to put up with many inconveniences. Many are under the impression that when they get to sea they will have all the home comforts they have formerly been accustomed to. In this they will be very much mistaken, even in the best-regulated boats; but with patience, perseverance, and civility, our young engineer will gain a position and experience which it is impossible to get elsewhere.

If any further information is required, the writer would refer them to such books as Reed's or Bergen's "Handbook for Marine Engineers," or Thorn's "Hints to Sea-going Engineers."

Chief Engineer.

Marine Engine Design.—II.*

In an article published in The Mechanical World for August 12, the writer considered the general considerations that influence marine engine design, and referred more fully to the case of a supposed engine for a cargo steamer, selected as an example, dealing with its arrangement of cylinders, jackets, pistons, piston rods, and cylinder covers. It is now proposed to continue the notes regarding the designs of this proposed engine, which was of the usual vertical triple-expansion type, having cylinders of 22in., 35in., and 58in. diameter, by 3ft. 6in. stroke, to develop about 1000I.H.P. at 65 revolutions. The engine was to have a piston valve for the high-pressure cylinder, and double-ported slide valves for the other two cylinders, the high and intermediate pressure valves being between their respective cylinders, and the low-pressure valve between the intermediate and low-pressure cylinders, all worked direct by the ordinary double-eccentric valve gear. The high-pressure cylinder only was to have a liner, but was not to be steam jacketed, and the piston rods were not to be continued through the covers. All the receiver passages would be formed in the cylinder castings, which are all bolted together, forming a common casing for the high and intermediate valves, and having a band cast round the back of the intermediate cylinder, connecting its exhaust port with the low-pressure casing space. Under this band another would be formed connecting the low-pressure exhaust space with the intermediate cylinder back foot, thus leading the exhaust steam down the middle back column, and conveying it into the centre part of the condenser. As there is only one air pump, worked off the low-pressure crosshead by links and levers, there should be a division plate cast in the condenser under the exhaust orifice, so placed that the steam is directed by it towards the forward part of the condenser, otherwise the tube surface in that quarter will be very inefficient, the natural passage for the steam to take being towards the air-pump suction. For this reason the practice sometimes adopted of taking the exhaust steam down the aft column, the single air pump being also worked at that end, is bad for the condenser, and should be avoided.

We have traced the steam connections through the engine to the condenser, and will now consider its transfer from the boilers to the engines, which opens up the main steam question. Brazed copper pipes have not proved an unqualified success for high-pressure steam, as has been shown by several fatal accidents, and various remedies have been tried, with more or less success. Some engineers retain the copper pipe, but reinforce it by winding steel or copper wire round it, or else clamp it with wrought iron or steel hoops at short intervals, whereas others have abandoned copper as the material, adopting wrought-iron pipes, welded as a rule, though sometimes riveted. As to the relative merits of the two methods, the Board of Trade authorities seem to favour reinforced copper at present, though their reasons for doing so are not very clear. To carry out this plan properly, it should be done by winding wire under tension continuously on the pipe throughout its length; this method is usually adopted in the British Navy, the wire used being of best copper. In the German Atlantic liner "Columbia," built by Messrs. Laird, at Birkenhead, a steel-wire rope is used for the purpose. The objections usually made to wrought-iron pipes have reference to the weld; but surely a weld in an iron pipe is as reliable as a brazed joint in a copper one. Considering the critical temperatures that pipes are heated to in the brazing process, it is a matter of surprise that the metal is not damaged more frequently. Other objectors think that the action of the steam may injure wrought-iron pipes; but such pipes, after many years' service, have been found in excellent condition, both as regards surface and strength, and there does not seem to be any reason why they should not be. Surely these imaginary dangers are not so weighty as the proved dangers of copper pipes. A piece of the main steam pipe of the "Great Eastern," which was of wrought iron, was recently tested, and was found to be in good condition. Whatever the material of the main steam pipes of a ship may be, very much depends on their arrangement, and certainly in the past this feature has not usually been sufficiently studied. For the proposed engine, the writer would suggest that the main steam pipes should be of wrought iron of good quality, lap welded, test pieces being cut from the ends of each piece and tested longitudinally and transversely at a plain part and across the weld; the flanges to be of cast steel, screwed on, and each pipe to be perfectly straight, one end being contained in a stuffing-box to allow for expansion; the bends being of cast iron, stayed in such a manner that the pipes are not subject to longitudinal pressure. All the main steam pipes, valves, bends, etc., to be tested to double the working pressure by water. The passages in the valves to be extra large, and as direct as possible, and the bends as easy as practicable.

We will now consider the valves, beginning with the high-pressure, which is of the piston type, admitting the steam past its inner edges from the centre of the casing and exhausting at the ends, the upper piston being slightly larger in diameter than the lower one, so as to balance the weight of the valves and gear, instead of using the usual separate balance piston. This design of valve has the further merit of exposing the valve spindle stuffing box to steam of receiver pressure only, and not boiler pressure steam, as in the case where the steam enters from the ends of the casing. The edges of the valve liners should all be well bevelled, so as to facilitate removing and replacing the valve.

There is much difference of opinion regarding the best packing for piston valves, most high-class designs having split rings, with springs of various kinds behind them, the coach-spring type being often used, though it is not very suitable for the purpose, as it may very easily produce an excessive pressure between the ring and the liner, and its action is in any case very indefinite. If a spring is used at all, it should be of a fairly elastic kind, not requiring a very nice adjustment, and enabling the amount of pressure to be at least roughly judged. Springless valves are gaining in favour, especially for such cases as we are considering, where the cost has to be kept down, and when well designed they serve very well. Though they have sometimes been made with solid plugs, which cannot be renewed, a much better plan is to have a separate deep uncut ring firmly fitted to the piston and kept down by junk rings, as they can be replaced when worn, a spare ring being carried for that purpose. This latter plan the writer would adopt in this case, having shallow grooves turned on the surface of the rings, which would help to keep them steam tight. The ring is sometimes made in two or three segments, bolted together by inside flanges, with the object of lining up when worn; but as this is a very imperfect method of adjustment, the result is not likely to be satisfactory. Of course the joints are slanted, so as not to score the barrel. The material of the rings and of the valve would be cast iron, the former being of a special hard, close-grained kind.

The intermediate and low-pressure slide valves should be kept as small as possible without curtailing the proper area for steam, which may be such as to give a speed through the ports at "port open" in full gear of 100ft. per second for the intermediate valve, 180ft. for the high-pressure valve, and 220ft. for the low-pressure. There should be a false face for both valves, pinned on to the cylinders, and the width of the bars and ports should be a minimum, so as to reduce the size of valves. Some makers use a shorter travel for the slide valves than for the high-pressure valve, but as this lengthens the ports, increasing the clearance space in the intermediate and high-pressure cylinders, the practice does not seem to be justified.

*This article has been awarded a prize in our Monthly Competition.

Shipbuilding Notes.

Messrs. Workman, Clark and Co. Limited, Belfast, launched on the 15th inst. a steel twin-screw steamer. The dimensions are:—Length, 126ft.; breadth, 23ft.; depth (moulded), 11ft. 7in. The builders supply two sets of compound direct-acting engines, having cylinders 16in. and 30in. diameter by 18in. stroke.

On the 20th inst., Messrs. Ropner and Son launched a steel screw steamer of the following dimensions:—Length between perpendiculars, 305ft.; breadth, 40ft. 6in.; depth moulded, 23ft. 7in. Her triple-expansion engines are by Messrs. Blair and Co. Limited, of 1000I.H.P. with two large steel boilers, working at 160lb.

The arrangements for laying down the new armoured ship "Magnificent," to be constructed in Chatham Dockyard, are now being made. It is intended to begin the actual work of construction early in the approaching financial year. It is also intended to begin the building of a second large battleship in Chatham Dockyard during the present year.

On the 18th inst., Messrs. Richardson, Duck and Co. launched from their yard a screw steamer for the Tees Union Shipping Company. The dimensions are:—Length over all, 173ft.; breadth, extreme, 26ft.; depth, moulded, 13ft.; gross tonnage, 550 tons. The triple-expansion engines are by Messrs. Blair and Co., and have cylinders 16½, 27, and 44in. diameter, by 30in. stroke.

The Union Steamship Company's new steel twin-screw steamer "Goth," which has been built for their service to and from South Africa, was launched on the 16th inst. from Messrs. Harland and Wolff's yard at Belfast. The gross tonnage will be about 4830, and she will be propelled by manganese-bronze twin screws, driven by two sets of triple-expansion engines developing an indicated horse-power of about 2000.

On the 16th inst. there was launched from the yard of Messrs. Ramage and Ferguson Ltd., a steam yacht of about 380 tons. Her principal dimensions are:—166ft. by 22ft. by 14ft. 6in. moulded. She is fitted with triple-expansion engines, having cylinders 15in. by 24in. by 39in. diameter, by 24in. stroke, supplied with steam from a large single-ended steel boiler working at 160lb. pressure.

On the 18th inst., Messrs. William Gray and Co. Limited launched a steel screw steamer, which has been built to the order of the West Hartlepool Steam Navigation Company. The dimensions are:—Length over all, 336ft.; breadth, 41ft. 6in.; depth, 24ft. Triple-expansion engines will be supplied by the builders. They will develop over 1200H.P. The cylinders are 24, 38, and 64in. diameter, with a piston stroke of 42in. Steam will be obtained from five large steel boilers, having a working pressure of 164lb. per square inch.

The steamer "Sibun," built by Messrs. J. Blumer and Co., was taken for trial at sea on the 11th inst. She is 260ft. long, 37ft. beam, and 17ft. deep. Her engines have been built by Messrs. Geo. Clarke Limited, and have cylinders 22, 36, and 59in. diameter, by 39in. stroke. Steam at 160lb. pressure is supplied by two boilers 14ft. diameter by 10ft. long. The trial was satisfactory, although there was a strong breeze. The engines indicated about 1050H.P., and drove the ship at a mean speed of 11 knots as the result of four runs upon the measured mile.

The Institution of Civil Engineers.

At the ordinary meeting on Tuesday, the 14th March, Mr. Harrison Hayter, president, in the chair, a paper by Mr. Thomas Sopwith, M. Inst. C.E., was read, giving an account of the breakdown of the Cunard steamship "Umbria," and of the steps taken on board to repair the damage.

Particulars of the voyage of the "Umbria," and of the weather experienced during her passage from Liverpool to New York on the occasion in question, were given. She sailed from Liverpool on the 17th December, 1892, called at Queenstown on the following day, and, after encountering a violent storm, broke down on the 23rd December, when 760 miles east of New York.

At 5-30 p.m. on that day, one of the thrust-block shoes began to jump violently, probably owing to the action of a small piece of metal which had become detached from the fractured portion of the shaft. The engines were immediately stopped, and three or four of the thrust-block shoes were removed, when a serious fracture was discovered between Nos. 3 and 4 collars, at the end near the engine. The fracture extended round the shoulder of one collar for nearly the whole circumference of the shaft, and then took a lateral direction to the other collar, following close against the shoulder of the latter for about 17in. Thus, although greatly weakened, the shaft was not completely severed. The diameter of the shaft, which was steel, was 25in.

Three slots were cut in the collars, which were 3½in. thick, and projected nearly 6in. from the shaft. The slots were 4½in. broad by 4⅞in. deep, and the bolts were fitted into them and between the collars. The bulk of the metal was removed by drilling holes with a ratchet brace and by afterwards chipping away with hammer and chisel that which remained. The labour required of the engineering staff was great, and was not only severe in its nature, but had to be done in a rolling ship, in confined space, and under a high temperature. During many hours a spell of 15 to 20 minutes was as long as a man could work continuously. Whilst that work was being carried out on the shaft, the preparation of the bolts was proceeded with, and for this a vice, hammer, and chisel were the only appliances available. It soon became apparent that the head and nut of each of the bolts would have to be reduced in thickness, because there was not sufficient clearance for them to pass the cast-iron ribs on the bedplate which carries the thrust blocks. This entailed much extra work, for the heads and nuts had to be bored through by numberless small holes, to separate the superfluous metal. The chief engineer was not disposed to destroy any portion of the permanent structure of the vessel by smashing away those portions of the ribs in the bedplate which prevented him from putting in the bolts with heads and nuts of full strength. The repairs which carried the vessel into New York were shown in a full-sized model. They consisted essentially of a strong hoop over the fracture in the shaft, the bolts already described, and an outside hoop to keep the latter in their places.

Notwithstanding the great strain they had been subjected to, the engineering staff kept actively at work preparing duplicates of every part which might break; and if it should have become necessary to supplement the three bolts already mentioned by others, this course would have been adopted and the strength of the repairs would thereby have been considerably increased. It was impossible to determine the efficiency of the repairs on account of the unknown factor represented by the strength of the broken shaft; but it might be assumed that it was not more than 6 to 7 per cent. of the efficiency of a perfect shaft. The repairs were continued night and day from the evening of the 23rd December until the morning of the 27th. The vessel reached New York at 9 a.m. on the 31st December, her speed having been increased from 4 knots to 10 knots per hour as confidence was gained in the efficiency of the repairs. Fortunately the weather, after the completion of the repairs, was fine, but the captain had a difficult task to get the ship into port, crowded, as that of New York always is, with vessels and ferries of all descriptions; for the engines, once started, had to go, and, once stopped, to stay, and anything like reversing could not have been safely attempted under the circumstances.

On the new East Coast Railway in India some steel ties were laid down, but it has been decided to replace them, on account of the very rapid corrosion due to the excessive moisture of the climate. All ties for this line are to be of pine, treated by the creosote process.

Compound Expansion Engine.

(Continued from page 105.)

That in some manner the prevention of loss of heat is accomplished by compounding seems to be the only means of solving the problem, and in that direction we may seek by calculation to ascertain the possibilities. In making the comparison, of course, we must assume the single-cylinder engine to be of the proportions of diameter and stroke (with relation to the point of cut-off) conformable to the best modern practice, and thus we may ascertain the comparative relations between a given volume of steam and the resultant work in foot-pounds by the respective systems. For the compound engine the above proportions of area and stroke and the cut-off are about correct, being 11·2875in. diameter (100 sq. in. area) for small, and 25·2313in. diameter (500 sq. in. area) for large cylinder, and stroke of 24in. The point of cut-off, one-fifth of 24in., = 4·8in. The equivalent single cylinder may be found as follows:—The volume of steam is 100 sq. in. × 4·8in. cut-off = 480 cub. in. As the expansion ratio is 25, the volume of cylinder will be 480 × 25 = 12,000 cub. in.

If we call the stroke 36in., we have $\frac{12,000}{36}$ = 333⅓ sq. in. area, and $\sqrt{\frac{333\frac{1}{3}}{0·7854}}$ = 20·6in. diameter. The point of cut-off $= \frac{36}{25} =$ 1·44in., and the length of stroke during expansion is 36 − 1·44 = 34·56in. To recapitulate, we have to compare the useful mechanical effect from 480 cub. in. of steam, at 110lb. boiler pressure, and vacuum of 20in., in a single-cylinder condensing engine of 20·6in. diameter (333⅓ sq. in. area) by 36in. stroke, cutting off at 1-25th, or 1·44in., with the equivalent in a two-cylinder compound engine (condensing) having a high-pressure cylinder of 11·2875in. diameter (100 sq. in. area), and low-pressure cylinder 25·2313in. diameter (500 sq. in. area), by 24in. stroke, the point of cut-off being one-fifth, or 4·8in. For both engines we may assume a rotative speed of 60 revolutions per minute; and to simplify the calculations of heat transmission, the cylinders may be regarded as unjacketed and exposed to a uniform atmospheric temperature of 60° F.

By referring to our previous calculation, from which the efficiency of the two engines was shown to be equal, it will be seen that no account was taken of the loss of pressure due to cylinder condensation, and that—except in so far as it is modified by the use of the hyperbolic logarithm denoting the theoretical expansion curve—the figures were based upon the simple law of Mariotte. As, however, an essential condition of this law of expansion is absolute uniformity of temperature, it is clearly inapplicable to the comparison, unless the loss of temperature can be shown to be the same in both engines. That the degree and sources of this loss are not the same is well known, and unless the difference can account for the greater proportion of the amount of superiority shown to result from use of the compound-expansion principle, it must be a difficult matter to locate the cause.

In most of the published theories and data relating to this subject the assumption is made that the variations of temperature in the internal surfaces of the cylinder are equal to those of the volume of steam, from the initial temperature at the time of cut-off to that due to its terminal pressure after the limit of expansion has been reached; also, that these changes occur throughout the entire length of the cylinder, notwithstanding the fact that beyond the point of cut-off the cylinder is at no time exposed to the initial temperature of the steam, and that therefore the mean, and not the maximum, cylinder temperature should be considered with relation to the mean temperature of the steam throughout the stroke.

With reference to the first point, the elementary laws of heat are directly opposed to the hypothesis of such rapid transmission from the steam to cylinder, and *vice versâ*, as would be necessary to equalisation of temperature at each stroke of the piston, except in case of such low piston speeds as are now almost obsolete, and not to be considered in comparisons of modern practice. For instance, if we take the case of our single-cylinder engine, the steam enters at 125lb. (above vacuum), with a temperature of 344·2°, and cutting off at one-twenty-fifth stroke expands to 5lb., or 161·4°, the difference being 182·8°, which must be alternately abstracted from the steam and surface of cylinder to equalise the temperature. To show the fallacy of this proposition it is only necessary to analyse the facts as they actually exist. It is certainly true that the maximum temperature of the steam cannot extend beyond the point of cut-off, and that the limit of length to which the cylinder temperature can be raised by that of the steam is restricted to the same point. The fall of pressure, and consequently of temperature, is very rapid immediately after cutting off (as shown graphically in the expansion curve of indicator diagram), and, therefore, as the cylinder temperature cannot exceed at any given point that of the steam due to its degree of expansion when the piston has reached that point, the difference between the two must be very materially less than that given above.

Of course the comparatively high conductivity of the iron will somewhat modify the temperature throughout the length, but, as we shall see later, it will not be of more than minor importance in its effects. It would seem clear, then, that the mean temperature of steam for the entire stroke and its resultant effect on that of the cylinder should be the basis upon which to calculate the effects of variation, and that the difference at any one point may be found from the corresponding pressure due to the rate of expansion reached.

Taking the previous figures, we may find the mean temperature from the mean pressure calculated by the formula, which we have seen to be 21·095lb., and the corresponding temperature is 231·5°, which we may assume to be also that of the internal surface of the cylinder for its whole length, disregarding for the present the external loss by radiation, etc. The mean difference of temperatures then will be 344° − 231·5° = 112·5°, say 112°, instead of 182°, as above, or nearly 38½ per cent. less. In order to go a little more into detail, the following table has been arranged to represent the stroke of piston divided into 25 equal parts, denoting each an increment of expansion, for which are given the mean and terminal pressures, and the respective temperatures due to each:—

Expansions.	Mean Pressure, $P\frac{1+H}{R}$	Mean Temperature.	Terminal Pressure, $\frac{P}{R}$	Terminal Temperature.
	Pounds above Vacuum.	Degrees Fahr.	Pounds above Vacuum.	Degrees Fahr.
1, cut off.	125·0	344·1	125·0	344·1
2....	105·82	331·7	62·50	299·0
3....	87·44	318·1	41·667	272·5
4....	74·97	307·1	31·25	254·0
5....	65·235	298·1	25·0	241·0
6....	58·16	290·5	20·833	233·1
7....	52·6	284·1	17·86	222·0
8....	48·1	278·5	15·625	215·0
9....	44·4	273·5	13·9	209·2
10....	41·28	269·3	12·5	203·3
11....	38·61	265·0	11·36	199·3
12....	36·3	261·4	10·42	195·2
13....	34·35	258·1	9·615	191·4
14....	32·49	254·9	8·98	188·0
15....	30·9	252·1	8·333	184·8
16....	29·475	249·3	7·8125	181·8
17....	28·19	246·8	7·353	179·1
18....	27·0	244·3	7·0	176·9
19....	25·95	242·1	6·6	174·0
20....	24·97	240·1	6·25	171·9
21....	24·08	237·8	6·0	170·2
22....	23·17	236·6	5·68	167·7
23....	22·47	234·3	5·46	166·0
24....	21·75	232·4	5·20	164·0
25....	21·095	231·0	5·0	161·4

Referring to the table, line 1 represents the point at which the steam is cut off, and line 2 the position of piston when steam has expanded to double its volume, and consequently $\left(\text{by } \frac{P}{R}\right)$ to one-half the initial pressure, or 62½lb., as per column 4. The extreme difference of temperature occurring between point of cut-off and line 2 is 344° − 299° = 45°, while the mean temperature during the interval we find to be 331·7°, or but 12·4° difference. Let us assume that the internal surface of cylinder included in space 1 has acquired the full initial temperature of the steam—344°—at the instant of cut-off, and calculate the possible amount by which the temperature of space 2, at line 2, can exceed that due to the terminal pressure, or 299°.

The only source from which any increase is possible is the conductivity of the iron and the parallel radiation from piston and cylinder head. The former quantity will be for each degree of difference in temperatures 233 heat units per hour for 1in. of length of cylinder wall, and inversely as the whole length. Then, as one stroke is 36in., and the 25 spaces represent each $\frac{36}{25}$ = 1·44in., the conduction will be $\frac{233}{144}$ = 161·8 heat units, which, multiplied by the extreme difference, 45°, = 7281 heat units per square foot per hour. The cylinder being 20·6in. in diameter, and, say, 1in. thick, the area of conduction will be (22·6 × 0·7854) −(20·6 × 0·7854) × $\frac{1}{144}$ = 0·4856 sq. ft., which × 7281 = 3536 total heat units per hour. Now, as our piston speed is 3ft. × 2 × 60 revolutions per minute = 360ft., the mean time required to travel 1·44in. will be 1·44 ÷ (360ft. × 60 minutes × 12in.) = $\frac{1·44}{259,200}$ = 0·000005½ hour, which × 3536 heat units = 0·019,448 unit as the amount of heat transmitted by conduction from first to second space during expansion. By absorption of radiant heat from surfaces exposed to initial temperature we may ignore the source and assume that the amount is sufficient to furnish all that the absorbing power of the cooler surface can receive. The amount of surface is (20·6in. × 3·1416 × 1·44) ÷ 144 = 0.647 sq. ft. The radiating and absorbing power of clean cast iron is 0·648 heat unit per square foot per hour for each degree of difference between the radiant and absorbent. Then 0·648 × 0·647 × 45 × 0·000005½ = 0·00010377 heat unit, which + 0·019448 by conduction = say 0·019552 unit as the total amount possible for increasing the heat of cylinder surface in the second space above that due to terminal temperature of the steam.

(To be continued.)

Trade Notes.

The Renfrew Forge and Steel Company, Renfrew, have contracted to supply the steel forgings required by the Clyde Trust.

The Moss Bay Hematite Iron and Steel Co. Limited, Workington, have secured an order for 10,000 tons of light section rails.

Messrs. Brownlie and Murray, Glasgow, have secured the contract for the iron and steel required in the construction of the Dorset County Asylum.

Messrs. William Beardmore and Co., of Glasgow, have booked an order for a heavy set of hollow shaftings for the Spanish Government, and also one for the Russian Government.

The Ashbury Railway Carriage and Wagon Company, Openshaw, near Manchester, have obtained an order for a thousand wagons from the Manchester, Sheffield and Lincolnshire Railway Company.

It is stated that Messrs. Carnegie and Co., of Homestead, Pennsylvania, have ordered from a Manchester firm a new press for their armour-plate works. It will be the largest piece of machinery of the kind in the country.

Messrs. Basse and Selve, Altena, West-phalia, are, in conjunction with English capitalists, about to commence the erection of large works in Duisburg, Westphalia, for the manufacture of electric cables and wires on a new and improved process.

Messrs. William Muir and Son, Man-chester, have just completed for a marine engineering firm on the Clyde a large vertical milling machine, the most powerful yet made. The machine weighs 18 tons, has a spindle 6in. in diameter, and a cutter 4in. in diameter and 12½in. long.

The report of the Teesside Iron and Engine Works Company Limited, for the year ending December, states that, after deducting £1739 for depreciation and expending a considerable amount in improved machinery out of revenue, the directors propose to pay a dividend of 4 per cent. on the preference shares.

The directors of Messrs. Charles Cam-mell and Co. Limited, Sheffield, recommend the payment of a further dividend for the year ended 31st December, 1892, which, when added to the instalment paid in October last, will make the entire dividend for the year 10 per cent. on the ordinary shares.

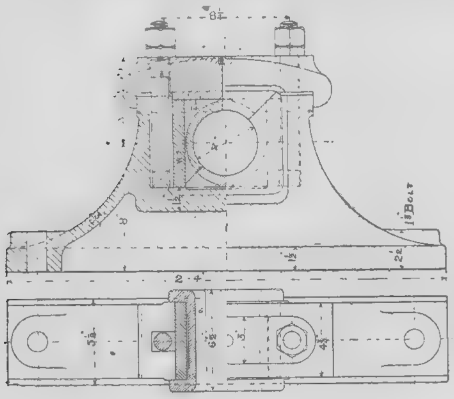
The Admiralty has decided that in future the standard and steering compasses of ships are to be lighted by electricity instead of by oil lamps. Each standard and steering compass is to be fitted with two 16C.P. incandescent lamps, capable of being switched on singly or together, the lamps being placed on opposite sides of the interior of the binnacle below the compass bowl.

Having regard to the enormous circula-tion of The Mechanical World, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if Mechanical World readers will kindly bear this in mind as occasion arises.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 85, Strand London, or New Bridge-street, Manchester.

The Design and Construction of Stationary Engines.—XLVIV.

Crankshaft Bearings and Pedestals.—These should be made as solid and rigid as possible, so that the shaft may always be held correctly in line, weak bearings being a source of much trouble and annoyance. A simple hole drilled through the solid casting presents the stiffest form of support for a shaft, but as there would be no means of taking up the wear which would take place, provision has to be made for future adjustments, and this necessitates the use of caps or covers, which allow of loose brasses or bearings being let into the casting. In the smaller types of engines the bearings are mostly fitted with simple brasses of circular form, in halves, fitted into the pedestal, which latter may either be loose and bolted on, or cast with the engine frame. The caps may be placed horizontally; very often they are arranged at an angle of 45°. The most usual proportion of length of bearings to diameter of shaft is from $1\frac{1}{2}$ to 2 times diameter in high-speed engines and those having heavy fly-wheels.



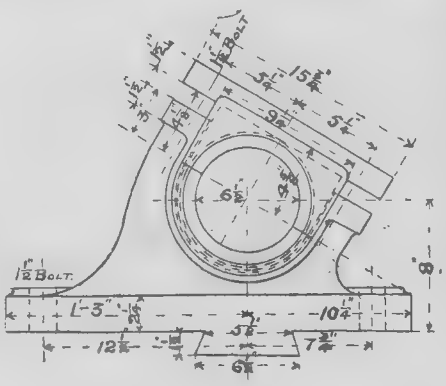
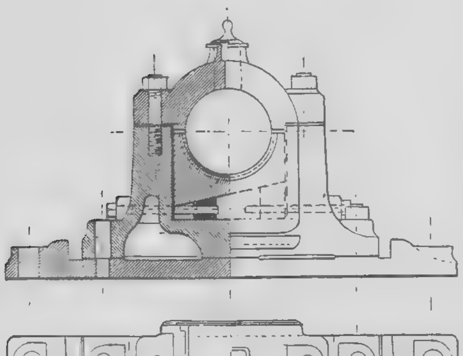


FIG. 207.—DESIGN, ETC., OF STATIONARY ENGINES.—FIG. 208.

Fig. 207 shows a substantial form of loose pedestal, suitable for ordinary high-pressure engines of moderate size. That illustrated was designed for a high-pressure horizontal engine having cylinder 12in. diameter by 24in. stroke, running 100 revolutions per minute. The line of separation of the brasses is at an angle of 45°. There is no great advantage in this, but it might be urged that in a horizontal engine the brass more rigidly encircles the shaft in the direct line of thrust than when the line of separation is horizontal. It mostly depends, however, on the fancy of the designer. To facilitate withdrawal of the shaft in this case, without lifting both brasses out at the same time, wrought-iron packing pieces are placed behind the brasses, which, when one or other is removed, allow of the top half of brass being moved sideways clear of the shaft, after which the shaft may be lifted out. The cap is of cast iron, and is provided with lips which fit over the end of the pedestal, and thereby greatly stiffen the sides of the pedestal. The fitting of the caps for this purpose should be very carefully and accurately done.



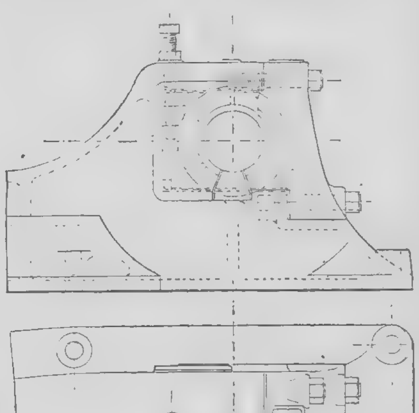


FIG. 211.—DESIGN, ETC., OF STATIONARY ENGINES.—FIG. 212.

Fig. 208 shows a form of angular pedestal often used for horizontal engines. The cap in this case is of wrought iron. The bottom half of brass is made circular, both in the body and in the fitting strips, and is machined to suit pedestal. The top half is circular in the body, with square fitting strips, to take the cover and fit sides of pedestal.

The bottom of the soleplate, it will be seen, is provided with a central joggle, which is let into a corresponding recess cast in the bedplate, and fixed with keys to relieve the bolts of all shearing stresses.

In many engines the pedestals are cast solid with the bedplate, and as a rule this is the best method, if the shop tools are suited to take in the work. Under some circumstances it may be cheaper to cast the pedestals separate and fit them to the bedplate.

Fig. 209 is a form of pedestal bearing used for vertical engines of the marine type, which is sufficiently clear to require no description. In vertical engines the wear takes place on the top and bottom brasses, and provision for adjustment need only be made in these directions. In the illustration the wear on the bottom bearing is made up by the insertion of thin liners underneath the brasses, and on the top by the screwing down of the cover.

In the better class of engines some means of adjustment for taking up wear in the brasses in one or more directions are usually provided, other than by the insertion of loose liners.

Fig. 210 shows one method practised on the Continent for taking up the wear in one direction only, with two-part brasses. It will be seen that this is effected by means of the set screws, the points of which bear against the front half of the brasses. Fig. 211 shows an American type of pedestal and soleplate designed for the out end bearing of crankshaft, in which the wear on the bottom brass is taken up by means of horizontal wedges and screws. Fig. 212 shows the bearing of the same designers formed in the end of the engine bedplate. The bearing, it will be seen, is in three parts; the centre portion can be adjusted by the insertion of liners, while wear on the left-hand portion is taken up by the wedge and screw arrangement; that on the right-hand part, by the closing in of the cap. These bearings are made of cast iron, lined with white metal.

(To be continued.)

THERE was launched at Devonport Dockyard, on the 17th inst., the second-class cruiser "Astræa." When completed she will have a displacement of 4360 tons, her dimensions being: — Length, 320ft.; breadth, $49\frac{1}{2}$ft.; mean load draught, 19ft. Her armament will consist of two 6in. and eight 4·7in. quick-firing guns, eight 6-pounder and one 3-pounder Hotchkiss, and four Nordenfeldt machine guns, in addition to four torpedo tubes.

Peat as Fuel.

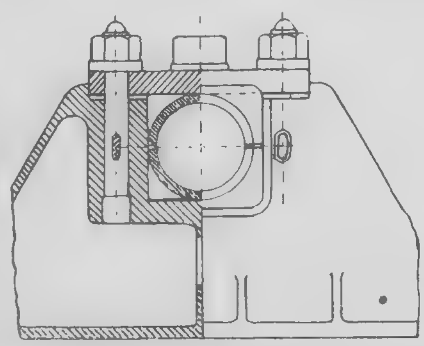
(Concluded from page 88.)

PEAT can be reduced to charcoal in a manner very similar to that employed in the case of wood, and the proportion of carbon contained by peat being greater than that of wood, the percentage of charcoal yielded is correspondingly greater. The average quantity of charcoal produced by the common stack or Meiler process from ordinary wood is about 22 per cent. When the distillation is carried on in close ovens this quantity is frequently increased to 27 per cent.; but as about 5 per cent. is required for heating the oven, this method in reality affords results very little superior to those obtained from the common charcoal mound. Peat, on the other hand, yields from 23 to $35\frac{1}{2}$ per cent. of its weight in charcoal on being charred in the ordinary way. The product of carbonisation in ovens is not greater than that obtained by the ordinary process, yet, the supply of air and the rapidity of charring being more easily regulated, the operation is more cheaply executed when ovens are employed. Lignite yields from 29 to 62 per cent. of charcoal or coke, while from the most suitable sorts of bituminous coal as much as 90 per cent. of their weight is yielded in coke; ordinary yields are from 65 to 75 per cent. The charcoal of peat is largely used on the continent of Europe for domestic purposes, its price being about the same as that of wood charcoal, and nearly twice that of mineral coal. Peat and coal have been employed in their uncarbonised condition for the smelting of iron ore, peat generally in conjunction with coal, while the latter is sometimes employed alone. Better results are obtained when the fuel is used in the carbonised form, as coal usually contains a considerable percentage of sulphur, which is very deleterious to the product of iron, and which is wholly or partially got rid of by carbonisation, and the charcoal and coke yield a greater intensity of heat in combustion than the raw fuels. Sir Lowthian Bell, one of the greatest living authorities on the manufacture of iron, places a low estimate upon the value of peat as a fuel for the smelting of iron. He says:—In 1876 a trial was made with compressed peat at one of the Vordenberg furnaces. Particulars of the experiment are given by Anton Einigl. When about 29 per cent. of the total weight of fuel was peat, the remainder being charcoal, the actual work done was such that one ton of the charcoal was worth nearly three tons of the peat. The low value of peat as a blast furnace fuel is due to the large quantity of water and volatile gases it contains. Of the really useful constituent—viz., fixed carbon—it gave only in this case 32 per cent. The statements just made in reference to lignite and peat may be accepted as an indication of the great inferiority of these varieties of fuel as compared with charcoal or ordinary coke for the purpose of smelting iron.

At Konigsbronn, in Wurtemburg, at Ransko, in Bohemia, and elsewhere on the continent of Europe, on the other hand, satisfactory results are said to have been obtained in the smelting of iron by the use of air-dried peat alone or mixed with a nearly equal weight of wood charcoal. Peat has even been used in Canada in the manufacture of iron, and to good effect, as will be seen by the following statement:—

Mr. McDougall, of the Caledonia Ironworks, Montreal, who supplies the Grand Trunk Railway with car wheels, states that for giving toughness to the metal and uniformity of chill, qualities so essential to car wheels, peat fuel is unsurpassed. We have the following brief report of an experiment in smelting iron with peat at these works:—The cupola was charged with two layers of iron and anthracite coal. The third and topmost layer was iron and peat. The time was forty minutes less than with coals alone. The iron smelted by the peat was hotter when drawn off from the coals, and was said to be more compact and more like wrought iron than the other. The test was a severe one, the proportion being twelve of iron to one of peat; the proportion for coals being seven to one.

Peat charcoal, especially that made from compressed peat, appears to be much preferable to the uncarbonised article in the smelting or refining of iron. Charcoal prepared from common air-dried peat is subject to disadvantages which prevent its general application to ordinary metallurgical purposes. Being light and friable, it soon falls to pieces, and is thereby rendered worthless as a fuel. In smelting furnaces, where it has to sustain the weight of the charges above it, this charcoal is found to crumble and choke the blast, and it can therefore be employed only under steam boilers, in forge fires, or in reverberatory furnaces. By coking compressed peat, however, the resulting charcoal may attain a density of 1·040, which is far superior to that of wood charcoal, and even equal to that of the best coke made from coal. In its calorific effects this charcoal is about the same as coal coke, and little inferior to wood charcoal. One advantage over coke which peat charcoal possesses in common with wood charcoal is its freedom from sulphur, which is frequently present in the former in proportions as high as 1 or even 2 per cent., to the great detriment of the iron produced. Tests show that the peat charcoal may be made to serve a very important use in the puddling and refining of iron, and in south-east Germany and Russia it is extensively used in metallurgical operations.



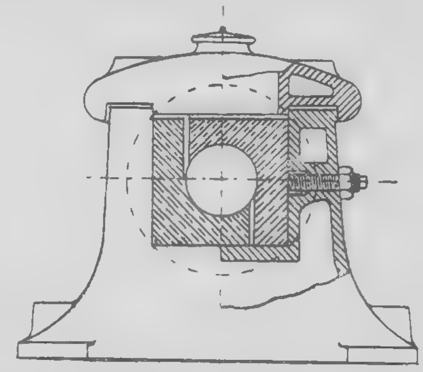


FIG. 209.—DESIGN, ETC., OF STATIONARY ENGINES.—FIG. 210.

State of the Skilled Labour Market.

THE following memorandum has been prepared for the "Board of Trade Journal" by the Labour Correspondent to the Board of Trade:—

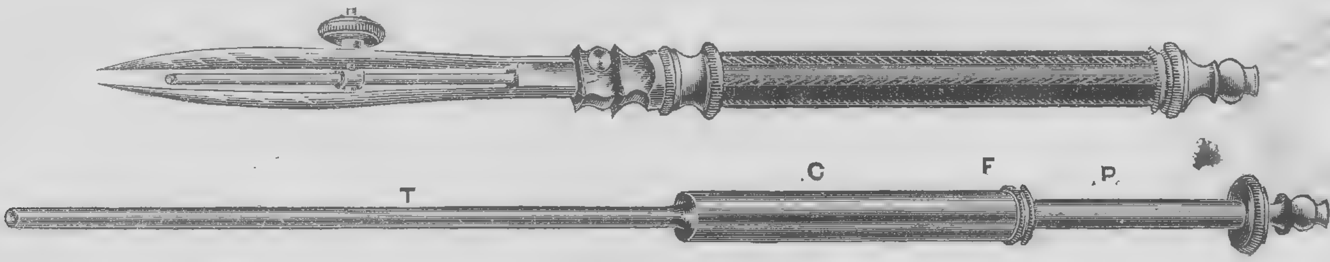
Although the condition of the skilled labour market continues unsettled, there are no fresh disputes of an important character to chronicle, the number of strikes during the month amounting to 37, as compared with 38 in the preceding month, and 48 in the corresponding period of 1892. Of those that have taken place since the last report, eight occurred in the mining industry, five in the metal trades, five in the building trades, four in the clothing trades, and the remainder in various other industries.

Notwithstanding the generally unsatisfactory state of the skilled trades, the number of unemployed in the majority of societies making returns is rather less than last month, only four showing an increased percentage of unemployed, against 11 in the former period. The aggregate membership of the 23 unions supplying information to the Board of Trade is 280,377, of whom 26,624 are stated to be in receipt of out-of-work benefit. The total number of members reported by the same societies to be unemployed last month was 27,845, so that there is thus a net decrease of 1221, the percentage for the period under review being 9·49, against 9·96 in the previous month. It will thus be seen that in the aggregate there is a general tendency towards improvement, though in no case to a very marked degree, for on analysing the returns more closely it is impossible to refer to any trade particularly the condition of which can with justice be described, taking all things into consideration, as very much better than last month. The engineering trades continue to show an improvement so far as the number of unemployed members are concerned, and the same may be said of the building trades to some extent; but the printing and kindred trades, especially in the metropolis, though somewhat busier than last month, are still very slack, looking to the period of the year at which we have arrived. The dispute in the Lancashire cotton trade has considerably paralysed that important industry, and though several efforts have been made to bring about a reconciliation between the contending parties, such efforts have so far proved futile.

The actual condition of the skilled trades can possibly be best gauged by the remarks accompanying the reports of the 23 unions whose returns have come to hand. In these reports 13 describe trade as "bad," 6 as "moderate," and only 4 as "good"—facts which speak for themselves and go far to prove the continued unsatisfactory state of the skilled labour market before referred to.

Reservoir Drawing Pen.

DRAUGHTSMEN scarcely need to be reminded of the inconvenience and loss of time experienced in replenishing the ordinary form of ruling pen, especially when strong lines are being put in. The pen shown herewith is intended to overcome these objections by providing a reservoir of ink which will keep the pen supplied for a considerable time. As will be seen, it consists of an ordinary hinged-nib drawing pen, provided with a hollow metal handle, into which fits a cylinder C, which is shown withdrawn from the handle in the lower illustration. The rod or plunger P serves to draw the Indian ink into the cylinder C, while the tube T is provided to carry the ink between the nibs of the pen. In using the pen the cylinder C is withdrawn from the handle by taking hold of the milled gland F, and filled with ink by dipping the lower end of the tube T into the liquid, and pulling out the plunger P to its extreme position. After wiping the tube, the whole cylinder is inserted (without, of course, disturbing the plunger) into the handle of the pen again. A slight push forward of the plunger P then serves to feed the pen with ink. When this is exhausted, the plunger is again pushed slightly forward and the pen is again replenished, and so on.



RESERVOIR DRAWING PEN.

In addition to the obvious advantages of this pen, it may be said that if it is wished to interrupt the work, it is only necessary to blow out the ink remaining between the nibs of the pen; the ink in the cylinder will keep good for days. While if it is desired at any time, when the reservoir is empty, to add a line or two to a drawing without replenishing the reservoir, this can be done by using the pen exactly as an ordinary pen. Again, should the reservoir attachment be lost or damaged, an excellent drawing pen still remains.

If the top of the cylinder is unscrewed by means of the milled gland F, the plunger P can be easily withdrawn for tightening or renewing the packing. The price (4s.) at which the pen is offered is very low, being actually less than is often charged for ordinary hinged-nib drawing pens.

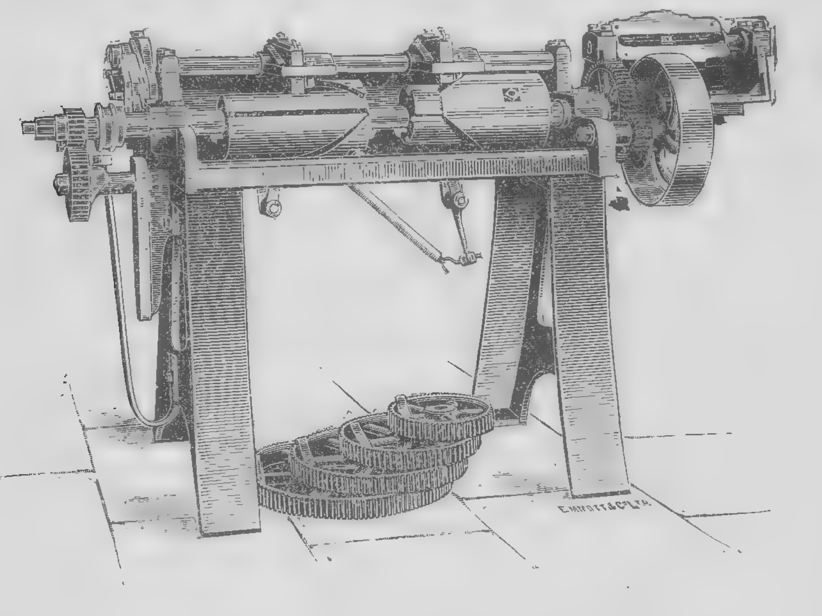
These pens, we may add, can be obtained with either metal or celluloid handles, from Messrs. Jackson Brothers Limited, 50, Call-lane, Leeds, which firm is also supplying some excellent scales of polished boxwood, in both "fully-divided" and "open-divided" forms.

Junior Engineering Society, New Swindon.

AT a meeting of this society, held in the Lecture-hall of the Mechanics' Institute, on Friday, March 17, Mr. W. H. S. Gange read a very useful paper, illustrated with sketches, entitled "Pistons and Piston Construction." He gave a detailed description of the principal of the many classes of pistons now in use, with the forms generally adopted in modern practice. He also dealt at length on the means of taking up the wear on the pistons by the use of rings of different forms, and on the methods used for adjusting them. Mr. Gange concluded with a brief account of some interesting piston explosions. Mr. Cresser advanced a device for securely fixing the piston and rod together, which, with some details of the paper, formed the chief points for the lengthy discussion that followed, in which Messrs. Leader, Kinneir, Davison, Moon, and Holt took part.

Wire-straightening and Cutting-off Machine.

HEREWITH we illustrate a simple and compact form of wire-straightening and cutting-off machine made by Messrs. C. H. Broughton and Co., Kirklees Ironworks, Brighouse. Only one straightener is used, and this very much reduces the space occupied by the machine, without affecting its efficiency. The return motion of the feed is effected by springs, thus reducing the noise to a minimum. The machine is made in two sizes, that illustrated being a single-geared machine 6ft. 2in. by 2ft. 4in. over all, which is capable of cutting from No. 9 B.W.G. to any higher numbers, while it will straighten and cut off accurately any length from 1in. to 16ft., or longer if required. The double-geared machine, which is adapted for cutting larger sizes of wire, is fitted with powerful double gear, and will cut wire from No. 9 to No. 000 on the B.W.G. This machine is 6ft. 7in. by 3ft. over all. The straightener is longer than that in the smaller machine, but both are accurately balanced—a point of considerable moment owing to the high speed employed. The set of the straightener and the arrangements for renewing the feed are very simple. The machines will cut according to gauge from 1 to 2cwt. per hour. We understand that these machines have been made for some time past, and have proved very satisfactory in working. Further particulars may be had upon application to the firm at the above address.


WIRE STRAIGHTENING AND CUTTING-OFF MACHINE.

Principles, Curiosities, Possibilities and Limitations of the Crank Motion.—No. II.

THERE are two general ways in which the thrust of a force acting in a straight line can be imparted to a crankpin.

First, the thrust against the crankpin may always be in a direction parallel with the direction in which the piston moves; and, second, the thrust may be in a direction the line of which forms a greater or less angle with the line of direction of the piston.

The parallelism of thrust with the direction of the piston's motion has been practically attained by the use of the well-known slotted crosshead, Fig. 1. Theoretically, the same result as to parallelism would be secured by a connecting-rod of infinite length.

The slotted crosshead, as ordinarily used, has advantages which would recommend it, were it not that its disadvantages are great. It admits of great compactness in construction, dispenses with a connecting-rod, and therefore eliminates from the design of valve-gear the necessity of considering peculiarities of motion arising from angularity of the connecting-rod with the direction of motion of the piston. Its faults, which for most purposes render it inferior to a pitman, are that its friction is greater than that of a pitman, and that it requires a much stronger piston rod to transmit the same power to the crank, owing to the strains that tend to bend the piston rod whenever the crankpin is in any position not in direct line with the stroke.

The rotative effort at any point of the first half of the stroke is, when following full stroke, the same as for the corresponding point of the second half. This is not the case with an ordinary connecting-rod, in which the shorter the rod length is in proportion to crank length, the greater is the difference between the rotative effort on the crankpin at corresponding points of the first half and second half of the stroke. This may, with the pitman connection, be carried to an extreme that will apply nearly the entire rotative effort to the crankpin during its revolution through 90° of arc from the beginning of the stroke, for the forward stroke, and during the 90° of arc that complete the revolution in the back stroke. Of this an example will be given before the completion of this series of articles.

The mean rotative effort on the crankpin during each semi-revolution, multiplied by the length in feet of the path described by the centre of the crankpin, less the work consumed by friction, is always equal to the product of the mean effective pressure on the piston multiplied by the length of stroke in feet, less the work consumed by friction; and each of these represents in foot-pounds the work performed by an engine under load, less work of friction. Ignorance of this fact has given rise in many instances to the belief that some substitute for the crank and pitman, by which the effort of the piston of a steam engine could be applied to rotation always at right angles with the direction of the movement of the piston, would result in an economy of power; and numerous inventions to secure this result in a more or less perfect manner have been made subjects for patents, some of them very curious examples of reasoning from false premises.

I have taken some trouble to prepare the accompanying tables, which contain very useful data. Table I. gives coefficients of rotative effort for a slotted crosshead movement, this being still used in some machines, such as steam pumps, air pumps, etc.

These coefficients are given for fifty different piston positions, the positions being indicated by decimal fractions of the stroke, as, 0·02, 0·04, etc. Each coefficient is a multiplier by which, if the pressure per square inch on the piston at the corresponding position be multiplied, the rotative effort on the crankpin per square inch of piston in that position will be obtained, friction being neglected. If the friction be considered as constant throughout the stroke, and as equivalent to any given per cent. of the piston's effort, then, by first deducting such percentage from the pressure per square inch on the piston, and multiplying the remainder by the coefficient of rotative effort at the given point of stroke, the net rotative effort per square inch of piston will be obtained, which, multiplied by the area of the piston in inches, will give the total net rotative effort on the crankpin at that particular piston position. Example: A piston of 10in. diameter has made three-fourths its stroke, and has at that point exerted upon it an unbalanced pressure of 7lb. per square inch. Disregarding friction, what rotative effort on the crankpin will it exert through the medium of a slotted crosshead?

TABLE I.—COEFFICIENTS OF ROTATIVE EFFORT EXERTED BY SLOTTED CROSSHEAD AT DIFFERENT PISTON POSITIONS AND CRANK ANGLES.

(PISTON POSITIONS ARE INDICATED IN FRACTIONS OF THE STROKE.)

Piston Positions.	Crank Angles.	Coefficients of Rotative Effort.	Piston Positions.	Crank Angles.	Coefficients of Rotative Effort.
0·02	16° 15′	0·2798	0·52	92° 18′	0·9992
0·04	23° 4′	0·3918	0·54	94° 36′	0·9968
0·06	28° 21′	0·4749	0·56	96° 54′	0·9928
0·08	32° 51′	0·5424	0·58	99° 13′	0·9871
0·10	36° 52′	0·6000	0·60	101° 32′	0·9798
0·12	40° 32′	0·6499	0·62	103° 53′	0·9708
0·14	43° 56′	0·6938	0·64	106° 16′	0·9500
0·16	47° 9′	0·7331	0·66	108° 40′	0·9474
0·18	50° 12′	0·7683	0·68	111° 6′	0·9330
0·20	53° 7′	0·7999	0·70	113° 35′	0·9165
0·22	55° 56′	0·8284	0·72	116° 6′	0·8980
0·24	58° 40′	0·8542	0·74	118° 41′	0·8773
0·26	61° 19′	0·8773	0·76	121° 20′	0·8542
0·28	63° 54′	0·8980	0·78	124° 4′	0·8284
0·30	66° 25′	0·9165	0·80	126° 53′	0·7999
0·32	68° 54′	0·9330	0·82	129° 48′	0·7683
0·34	71° 20′	0·9474	0·84	132° 51′	0·7331
0·36	73° 44′	0·9500	0·86	136° 40′	0·6938
0·38	76° 7′	0·9708	0·88	139° 28′	0·6499
0·40	78° 28′	0·9798	0·90	143° 8′	0·6000
0·42	80° 47′	0·9871	0·92	147° 9′	0·5424
0·44	83° 6′	0·9928	0·94	151° 39′	0·4749
0·46	85° 24′	0·9968	0·96	156° 56′	0·3918
0·48	87° 42′	0·9992	0·98	163° 45′	0·2798
0·50	90° 00′	1·0000	1·00	180° 00′	0·0000

The pressure per square inch being 7lb., we find the coefficient from table for position 0·74 is 0·8773; and for position 0·76 it is 0·8542. The position for which the rotative effort is required being midway between the two positions taken from the table, we may find the coefficient for it with sufficient accuracy by adding the coefficients for positions 0·74 and 0·76, and dividing the sum by 2; thus,

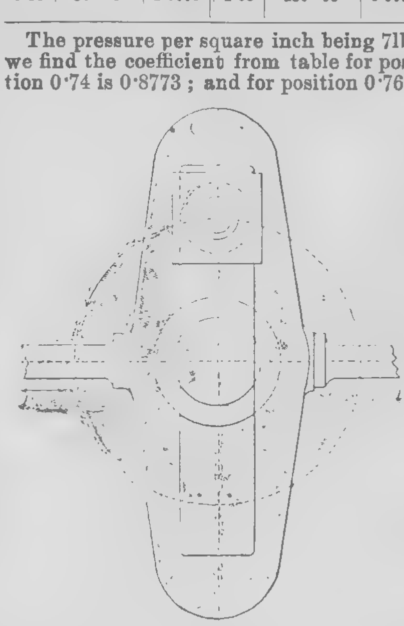


FIG. 1.

$$\frac{0{\cdot}8773 + 0{\cdot}8542}{2} = 0{\cdot}8657;$$

and this coefficient, multiplied by 7lb., and the product again multiplied by 78·54 (the area of the piston), gives the rotative effort,

$0{\cdot}8657 \times 7 \times 78{\cdot}54 = 475{\cdot}94$. The rotative effort is, therefore, in round numbers, 476lb.—that is to say, this is the pressure on the crankpin in the direction of rotation.

The full unbalanced pressure on the piston being $7 \times 78\ 54 = 550$lb., in round numbers, how is it that the rotative effort on the crankpin is only 476lb.? The answer is that the crankpin, at this point, while performing the same work as the piston, is moving faster than the piston; and as work is the product of pressure into distance, the piston, moving through the shorter distance, must move under a greater pressure to make the two work equal. It is as true for any part of the stroke, as for the entire stroke, that the work performed by the crankpin is equal to the work performed in the same time by the piston, less the work of friction.

The principle just enunciated is fundamental, and ought to be always in mind when considering the motion of the crank derived from a reciprocating piston; and, moreover, it is general in its application to any kind of connection by which the piston's motion can be transmitted to the crank, whether it be a slotted crosshead, a long or short connectingrod, any peculiar form of connectingrod, a beam connection, or some other mechanical appliance. Inspection of Table I. will show that the mean rotative effort for each semi-revolution of the crank by the slotted crosshead is the same, and that maximum rotative effort occurs at half-stroke, or at a crank angle of 90°. When this table is compared with Table II., which will follow in due course, it will be seen that the rotative effort of the ordinary pitman connection is quite different, the maximum rotary effort always occurring at a crank angle less than 90°, and the first half of each semi-revolution performing more than half the work of the stroke, even when steam is maintained at full pressure throughout the stroke. The disproportion is, of course, greatly increased when steam is cut off before the end of the stroke. The earlier the cut-off, and the shorter the pitman, the greater will be the disproportion. This property of the crank and pitman will be further considered subsequently.

The slotted crosshead, as generally used, with a rectilinear slot at right angles with the axis of the piston rod and crankpin working in a slide, as shown in Fig. 1, may be removed in such manner as to remove its principal disadvantages. Such improvement, and some modifications of the device securing certain possibilities of crank movement, will next be considered.

(To be continued.)

Metal Trade Memoranda.

The Landore Tinplate Works, Swansea, which have been idle for the last twelve months, are to be partially restarted next month.

The output of ore from the mines of the Marbella Iron Ore Company Limited last year amounted to 64,380 tons, as against 90,569 tons in the previous year.

The yield of gold in Victoria during the year 1892 was, according to the returns furnished to the Mines Department, 654,456oz., or an increase of 78,056oz. over that of the previous year.

It is stated that the Eston Steelworks. which have been idle since January, will be reopened early next month, orders having been secured which will enable the firm to carry them on regularly.

Two new furnaces of the Harvey type, for treating armour plates by the Harvey process, have been erected at the Bethlehem Ironworks. Pennsylvania. They are the first two completed out of seven contracted for by the Navy department.

New Companies.

Australasian Incandescent Gaslight Company Limited.—This company was registered on the 14th inst. with a capital of £35,000, in £1 shares, to carry on in different parts of the world, and especially in Australia and New Zealand, the business of manufacturers of and dealers in incandescent gaslights, fittings, accessories, and other gas lights; also the trades of electrical, mechanical and chemical engineers, builders and contractors. The number of directors is not to be less than 2. nor more than 5; qualification, £250; remuneration. £300 per annum. Registered office, 2, Bury-street, St. Mary Axe, E.C.

Godfrey Improved Printing Machine Company Limited.—This company was registered on the 10th inst., with a capital of £8000 in £10 shares, to acquire, take over, and work the business of printing machine makers now or lately carried on at Old-street, E.C., and to follow the business of printing machine manufacturers, ironfounders, metal workers, printers, publishers, lithographers, bookbinders, account book manufacturers. etc. The number of directors is not to be less than 3, nor more than 7, the first being Colonel H. J. Willett, J. Shaw, R. A. Stuart, and A. Godfrey; qualification. £100; remuneration, £3 on every machine sold and delivered up to 50 machines. Registered by William Agate, 38, Bow-lane, E.C.

Fowler's Engineering Company Limited.—This company was registered on the 14th inst., with a capital of £2000, in £5 shares, to carry on the businesses of mechanical engineers, iron and brass founders, metallurgists, etc., in all their branches. The rules of Table A apply in most cases. Registered office, Tooley-street, E.C.

Thomas Holt Limited.—This company was registered on the 10th inst., with a capital of £10,000, in £5 shares, to carry on, as may from time to time be determined, and in every branch, the business of machinists and mechanical engineers, tool makers, ironfounders, brassfounders, millwrights, joiners, and metal workers, and to acquire the business, property, assets and liabilities of the late Thomas Holt, now carrying on business at the Atlas Ironworks, Molesworth-street, Rochdale, Lancashire. The majority of the rules of Table A apply. Registered by C. Doubble, 14, Serjeant's Inn, E.C.

Electric Semaphore Signal Syndicate Limited.—This syndicate was registered on the 9th inst., with a capital of £3000, in £1 shares, to negotiate and make arrangements with Mr. A. J. Bailey, of Tremere, Sylvan road, Upper Norwood, Surrey, or, otherwise, the owners for the time being of certain British and Colonial letters patent, or provisional applications for such, for the manufacture of electrical signalling apparatus, and the development of these patents; to manufacture all kinds of signalling utensils, to create and produce electricity, magnetism, or other similar agency, and to carry on the business of electricians, etc. The rules of Table A generally apply. Registered by Franklin, Wild and Co., 5, Broad-street Avenue, E.C.

R. A. Lister and Co. Limited.—This company was registered on the 13th inst., with a capital of £20,000, in £20 shares, to purchase or otherwise acquire the fee-simple of or any less estate or interest in certain hereditaments and premises known as the Victoria Ironworks, at Dursley, Gloucester, with the goodwill of the business carried on at these works and elsewhere by R. A. Lister, and to follow the trades of iron and brass founders, mechanical engineers, and other similar businesses. The first directors are to be R. A. Lister, E. A. Lister, and C. A. Lister; remuneration to be fixed by the company in general meeting. The board is not to consist of more than 5 members. Registered by Waterlow Bros. and Layton, 24 and 25, Birchin-lane, E.C.

Electrolytic Separation Syndicate Limited.—This company was registered on the 11th inst., with a capital of £25,000, in 5000 preference and 20,000 ordinary shares of £1 each, to purchase and acquire patents, etc., conferring a right to use any inventions, and in particular the patent or other rights and privileges of Claude T. J. Vautin, for an invention for "improvements in the method of, and apparatus for, the electrolytical separation of the bases of salts and compounds of the same from saline solutions"; to enter into a certain agreement, and to carry on any business which the company may think convenient. The number of directors is not to be less than 2, nor more than 7; qualification, £100; remuneration, £100 per annum each, with £50 extra for the chairman. Registered by J. A. Maxwell, 97 and 98, Bishopsgate-street, London, E.C.

The Metal Market.

PRICES CURRENT.

LONDON, March 20.

Copper opened dull, the best bid for three months being £45 12s. 6d., which was accepted afterwards for one warrant. A small business was also done in cash at £45 5s. There was no pressure to sell, and on some buying orders being executed in the afternoon three months rallied to £45 13s. 9d., the market closing quiet at Friday's values. Sales, 250 tons. Settlement price, £45 5s. English tough, £48 10s.; best selected, £49 10s. to £49 15s.; strong sheets, £57.

Tin has been quiet but firm, and with holders offering sparingly prices have steadily hardened. Business began with cash at £95 5s. and subsequently £95 7s. 6d. was paid for a week. The end of May made £95 10s. publicly, but later on small lots were privately negotiated at £95 12s. 6d. to £95 15s. for prompts from the middle to the end of the month, and the close is firm for near and May dates. Three months, however, are 2s. 6d. to 5s. lower. Public sales did not exceed 50 tons. Settlement price, £95 5s. English ingots, £98 to £98 10s.

Pig Iron ruled inactive, operators showing little interest but after official hours 2000 tons were reported sold at 41s. 3d. for three months. Hematite closed 1½d. lower, but otherwise prices are unchanged. Settlement prices:—Scotch, 40s. 9d.; Middlesbrough, 34s. 5d.; hematite, 45s. 9d.

Tinplates steady and unchanged. I.C. cokes, f.o.b., London, 12s. 9d.; Liverpool, 12s. 3d.; Swansea, 11s. 9d.

Lead quiet, and the nearest price of Spanish is £9 15s; English, £9 17s. 6d. to £10.

Spelter is inactive, with sellers at Friday's value. March-April shipment, £17 6s. 3d.

Zinc Sheets.—Silesian dull but steady at £20 17s. 6d. to £21, ex ship. Belgian quiet; V.M. brand, £20 17s. 6d. ex ship, and £20 15s. f.o.b. Antwerp.

Official Closing Quotations.

	To-day.
Copper—	£ s. d. £ s. d.
G. M. B.—Cash	45 5 0—45 12 6
" Three months	45 13 9—46 1 3
Tin—	
Fine foreign—Cash	95 5 0—95 15 0
" " Three months	93 5 0—93 15 0
Australian—Cash	95 15 0—96 5 0
Pig Iron—	s. d.
Scotch warrants—Cash	40 9
" One month	40 11
Middlesbrough—Cash	34 5
" One month	34 7
Hematite—Cash	45 9
" One month	45 11

GLASGOW, March 20.—The pig iron market was quiet. At the opening the tone was firm on large shipments of Scotch last week, and 5000 tons sold, but in the afternoon only 1000 tons Scotch sold. The cash price varied only ½d.—40s. 10d. to 40s. 10½d., sellers, at last remaining at the lowest. Some lots with plants sold at 40s. 6d., 40s. 7d., and 40s. 7½d. The shipments of Scotch last week were 10,102 tons, being an increase on the corresponding week of 2755 tons, and making an increase for the year of 745 tons—Glasgow, 344,474; Middlesbrough, 55,494.

Quotations:—

	Scotch. Cash. s. d.	Scotch. 1 m'th. s. d.	Middlesbrough. Cash. s. d.	Middlesbrough. 1 m'th. s. d.	Hematite. Cash. s. d.	Hematite. 1 m'th. s. d.
Highest ..	40 10½	41 0½	34 5	34 7	45 10	—
Lowest ..	40 10	40 11	34 4	34 7	45 9	—
Close	40 10	40 11	34 5	34 7	45 9	—
Prev. close	40 9	40 11	34 5	34 7	45 10½	46 0

Official Gazette.

Partnerships Dissolved.

J. Clapham, T. Clapham, and W. Clapham, under the style of Clapham Brothers, Keighley, ironfounders; as far as regards J. Clapham.

S. J. Phillips, R. Maclaren, and L. A. Bell, under the style of Phillips, Nunes and Co., Llanelly, Carmarthenshire, bar iron and tinplate manufacturers; so far as regards L. A. Bell.

Sir James Brunlees, deceased, John Brunlees, and A. M'Kerrow, under the style of Brunlees and M'Kerrow, Victoria-street, S.W., civil engineers.

THE BANKRUPTCY ACTS, 1883 and 1890.

Receiving Orders.

E. J. Bayly, Liverpool, electrical engineer.

H. Learoyd, Southall, Middlesex, mechanical engineer.

A. J. Napper, Dawlish, Devonshire, machinist.

Adjudications.

E. J. Bayly, Liverpool, electrical engineer.

T. W. Siddaway, Southport, and late of West Bromwich, out of business, late ironfounder.

A. J. Napper, Dawlish, Devonshire, machinist.

Order made on Application for Discharge.

R. C. Robson, Newcastle-on-Tyne, millwright—discharge suspended for two months ending April 17, 1893.

Letters to the Editor.

*** *We do not hold ourselves responsible for opinions expressed by correspondents.*

*** *The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

*** *Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

SOME POPULAR FALLACIES CONCERNING ELECTRICITY AND MAGNETISM.

To the Editor of The Mechanical World.

Sir,—There is a widespread idea possessed by the public, and often the more intelligent portion of the public, that electricity and magnetism (in its essence) is something unexplainable, unknowable, and wonderful. A perusal of the majority of the works upon these subjects certainly is calculated to foster such ideas, for the most simple truths are often hidden by the thick dust of the battle waged by rival theorists and mathematicians. Many of the terms which are still retained in the popular text-books are a source of confusion to the earnest student, representing, as they do, ideas which are now defunct, although at one time very generally held.

Who now believes in electric fluids or magnetic fluids? They are as out of date as the "Phlogiston" of the eighteenth century. Then there is the popular notion that electricity is a thing or substance which can be got out of a dynamo as we pump water out of a well, and that it "flows" along a conductor like water flows through a pipe. Allied with this there is the far more insidious doctrine that there are "two kinds of electricities and two kinds of magnetism," and that similar kinds repel each other. So long as people retain the idea that electricity is a thing *per se*, so long will a number of grotesque conceptions prevail which cannot easily be removed.

However, we know that electricity and magnetism are not "things" any more than a sensation is a thing. Teachers should start by pointing to the sun as not only being the true source of electricity, but of all energy whatsoever.

To Clark Maxwell and Balfour Stewart we are indebted for that truly noble generalisation which shows that the energy developed by the sun's combustion is transmitted in undulatory waves along the ether of space, and this energy, entering the eyes of the animal creation, gives them light. But the same energy which appears to us as daylight prepares from a poisonous gas (carbonic anhydride) the food which builds up the cells and tissues of the vegetable world. Again, we know that the same energy, by polarising the molecules of elementary substances, causes such elements to unite and form compounds, at the same time locking up in such compounds a store of energy for the use of man, as in coal. The great globe itself is polarised by this energy and is one vast magnet, and also the minute molecule of iron is polarised by the same agency, and becomes possessed of poles which point themselves towards the earth's magnetic poles when free to do so. The molecular theory of magnetism is founded upon this polarising tendency of energy, and all magnetic phenomena are explained by it. It is about time that such phrases as "opposite kinds of electricity" were eliminated from the text-books, and the true explanation of electricity insisted on—*i.e.*, that what we perceive as electricity is really the result of a *motion* propagated along the ether, and which motion in its progress gives rise to various movements of matter. It is highly important to keep clearly and distinctly apart the two ideas which are here involved: the motion or sensatory effects which result from energy, and the energy which gives rises to, or is the cause of, such motion. If this be not done, confusion is certain to be the result, and the public will continue under the impression that an electrical current is a kind of substance, which may be measured as to its quantity like so many cubic feet of illuminating gas is—by passing it through a meter. In fact, many users of electricity who have an electricity meter on the premises are quite under the impression that the meter measures the quantity of a substance or thing supplied to them.

It cannot be too widely known that electrical "pressure" only can be generated, and that the dynamo does not generate "electricity" at all in the popular sense of drawing it out of the field magnets, so to say.

Another doctrine which will have to go is that similar kinds of electricity repel each other, and that there is repulsion between like poles of magnets. What is apparently repulsion is really the result of attraction when polarisation is set up, and this has been demonstrated by most eminent electricians (as J. T. Sprague and W. H. Preece); but in nearly every text-book they talk about attraction and repulsion till the idea is firmly rooted in people's minds that there is a separate repulsive force. There is no force of repulsion found in nature. People must think and study for themselves, and not take everything for granted because it is in a scientific book with a great name on the title page.

Derby, March 12. E. Woodhead.

THE AVOIDANCE OF SMOKE.

To the Editor of The Mechanical World.

Sir,—In reference to my letter in your issue of the 17th, three manufacturers have written that they will avail themselves of my offer to have the process applied to their works for £50 for two boilers, and several others are asking if £50 will be the whole cost of the plant and apparatus complete.

To these and others who may wish to know, permit me to answer, "Yes, so far as you are concerned." The total cost will be about £150 for each pair of boilers, but I will undertake to get the other £100 (£1000 in all) subscribed if ten (or, say, eight) manufacturers will give their support, dividing the profits, of course, but letting the manufacturers have the first £50 a year each. It will not be worth our while to undertake the work for less than eight places, because we shall have to employ a qualified engineer for the works, and his salary and making of plans will cost nearly as much for one place as for eight.

In reply to other questions, let me say:—(*a*) The gas plant and two boilers can be attended to by one man, as the quantity of coal required is reduced, and there is no stoking at the boilers. (*b*) The wear and tear of boilers is less than with coal firing. (*c*) The wear and tear of the gas plant is scarcely more than nominal. That I referred to has been in constant use, night and day, for eighteen months, and has not cost a penny for repairs. (*d*) There is not a particle of smoke at starting, nor at any other time. (*e*) There is no skilled labour required to work the producing plant; the man who attends to the boilers can do it. (*f*) A gas producer to supply two boilers requires a space 16ft. square. (*g*) It may be placed anywhere within, say, 20yds. of the boilers. Some people tell me they have tried gas, and did not find it answer. Very likely. They forgot, perhaps, that gas requires to be supplied with ten or twelve times its own volume of air, and they could not get that from chimney draught; and, further, that the air must be supplied hot, or it will not support combustion until it has passed partly through the furnace, and then there will be more heat in the chimney than in the boiler. I can point to a place where it does answer, and is in constant use, paying, for night and day

work, 300 per cent. on its cost. For ten hours' work it will give 100 per cent.

I submit, sir, that in view of the perfect immunity from smoke, and the reduced cost of all kinds of manufacture given by the use of gas with hot air under pressure, this is the most important and profitable enterprise of the day — electricity not excepted,—and that it ought to have the earnest support of all who wish to preserve health and make money.

T. NICHOLSON.

Tudno Villa, Colwyn Bay, March 20.

CHADWICK'S "SLIDE-RULE INSTRUCTOR."

To the Editor of THE MECHANICAL WORLD.

SIR,—I am much obliged for your review of "Slide-rule Instructor," but as to which I beg to make a few remarks. The earlier examples and exercises which you seem to deprecate are intended to give the pupil facility and dexterity in the use of the instrument, as well as confidence in its results, the accuracy of which he can readily test by other means.

Your suggestion as to placing a scale of gauge points on the back of the slide, ranging, say from 30lb. to 200lb. or more of initial pressure, giving the average pressure at all possible rates of expansion which may be applied, is altogether out of the question, inasmuch as there is not room. The rule given is a general solvent for all amounts of pressure and conditions of expansion possible.

In regard to mistakes in the book, it is wonderful there are so few, as it was printed and issued to the public without a final proof-sheet being submitted for inspection or correction.

JOHN CHADWICK.

Manchester, March 15.

[We publish the above letter with pleasure. We must, however, dissent from Mr. Chadwick's views, especially with regard to the gauge points for expanding steam. As a practical engineer, Mr. Chadwick will know that with about 20 degrees of cut-off, all ordinary cases of expanding steam may be dealt with, at any rate with sufficient accuracy for ordinary everyday requirements, and this is all that is ever claimed for slide-rule computations. It is certainly wasting time and effort to make refined calculation in such a case, when the effects of cylinder clearance and other causes are not taken into account. As for the room required for the gauge points, we may say that less than 3in. of the back of the slide is all that is necessary, and that this suffices for *all* pressures, and not merely those within the limits above referred to. Regarding the errors in the book, we are still of opinion that a work which is for the greater part a reprint should not contain the mistakes to which we alluded. For these, however, the author is apparently not to blame, as for the most part they are the consequences of careless "reading" and "making up." —ED. M. W.]

COMPOUND-EXPANSION ENGINES.

To the Editor of THE MECHANICAL WORLD.

SIR,—The article on compound-expansion engines which appeared in your last issue causes me to venture an observation or two. I have worked a compound engine, 16in. cylinder, which exhausted its steam into a cylinder 24in. diameter; the working pressure was 40lb. per inch. My employers increased the pressure to 80lb. per inch. The water of the condenser could always be kept cool previous to increasing the pressure, and the engine had no more to drive at 80 than it had at 40; but now the water cannot be kept cool for more than four days a week, and the vacuum was decreased as the heat was increased to a certain extent. The temperature of the steam at 80lb. would be 329° heat, and the temperature of steam at 40lb. 269°, so that the increased pressure to 80lb. was a waste of heat to the amount of 60°, as we were merely heating the water to no purpose. I should be pleased if the writer of the article would mention facts relating to this. He never mentions the temperature of various pressures of steam.

Radcliffe, March 17. CLOCK JOHN.

DURING the last five years the Prussian State Railways have built a great number of dwelling-houses for their employés, and they have now no less than 22,980 such dwellings, of which 458 are for officials of a higher class, 6500 for employés such as station foremen and assistants and roadmasters, and more than 16,000 for the lower grades of employés, and especially switchmen and track-walkers.

Miscellaneous Items.

It is intended to light up the railway carriages of the Berlin Town and Circular Railway by electricity.

A new typewriting machine of English invention and manufacture will shortly be placed on the market.

Twelve of the leading locomotive works in the United States built 1703 locomotives in the year 1892, as against 1968 the year previous.

The roof of the new station of the Pennsylvania Railroad Company at Philadelphia will, it is said, be the largest in the world. Its span is 300ft. 8in., and it is 600ft. long.

A lecture on printing machinery, with illustrations and samples of printing, was delivered on the 10th inst. at the Board School, Longsight, by Mr. E. Tomlinson, of Levenshulme.

The North-Eastern Railway Company intend testing improvements in signalling on their line between Waterhouses and Floss Junction. It is the invention of a working man, Mr. Simmons, of Esh Winning.

The Clifton Rocks Railway, a lift railway cut in a tunnel from the gorge of the Avon to the summit of Clifton Rocks, Bristol, was opened on the 11th inst. It runs from the top not far from the Clifton Suspension Bridge to the famous old Hotwells on the bank of the Avon. The work has taken two years to finish. The tunnel allows room for four cars to go abreast. Locomotion is secured by water power on the principle adopted largely on the Continent. A car going down balances one coming up, and *vice versâ*. The tunnel is lighted by gas, and the signals are worked by electricity, by a man at the top.

An important discovery as bearing upon the existence of coal has been made in South Cumberland. A shaft to win iron ore at a lower depth has been completed, and it was necessary to drift out from this shaft to the ore deposit a considerable distance, and in the course of this drift a large and valuable seam of fireclay was cut. The band of fireclay is about 50ft. thick, and this is now being used for the Millom and Askern blast furnaces. It is considered highly probable that this extensive deposit of fireclay points to the existence of coal, and steps will at once be taken to test the matter.

The first station of the Midland Railway Company on the old line from Leicester to Swannington, which was the first line built south of Liverpool and has been in use ever since, was on the 13th inst. discarded for a new building. The old structure was erected when George Stephenson built the line, and was opened for traffic on July 17, 1832. It was a very small two-storey building, and contained two rooms, of which the small upper one was used as a directors' boardroom. It was at this place that Stephenson ran his celebrated engine, the "Rocket," which was brought by canal to Leicester, and the old single line remains very much in its primitive condition, being used almost exclusively for the traffic to the Leicestershire coalfields for which it was constructed. The historic old building will remain undisturbed for the present. The new station is a plain, substantial building suitable for the small traffic on a branch line. When the old station was opened metal railway tickets were used and reissued as often as required. Some of these tickets have been presented to South Kensington Museum, and others will be exhibited at the World's Fair at Chicago.

Prize Competition.

WE OFFER FOUR GUINEAS MONTHLY IN PRIZES FOR THE BEST ORIGINAL ARTICLES SENT IN ON ANY MECHANICAL, ENGINEERING OR ELECTRICAL SUBJECT.

IN ORDER THAT MANAGERS, DRAUGHTSMEN, FOREMEN, AND WORKMEN WHO HAVE HAD NO PRACTICE IN WRITING MAY NOT HESITATE TO SEND IN COMPETITIONS, IT IS TO BE UNDERSTOOD THAT ALL ARTICLES WILL BE FULLY EDITED AND CORRECTED, AND JUDGED OF SOLELY ON THEIR MERITS AS ORIGINAL CONTRIBUTIONS FROM A PRACTICAL POINT OF VIEW. THE OBJECT OF THE COMPETITION IS TO INDUCE PRACTICAL MEN TO COME FORWARD AND GIVE THE RESULTS OF THEIR EXPERIENCE.

CONDITIONS.

Competitions for our Monthly Prizes must be sent so as to arrive at the Manchester Offices of THE MECHANICAL WORLD, New Bridge-street, not later than the last Tuesday in each month. Articles arriving after that time will be placed in the following month's competition.

Written competitions must be on one side of the paper only. The contributions must be original, and relate to matters connected with Engineering, Mechanism or Electricity.

The Proprietors of THE MECHANICAL WORLD reserve the right to publish any competition, whether it gains a prize or not.

The competitions may be accompanied by diagrams, sketches or drawings.

Competitors should write the words "Prize Competition" on the envelopes.

Competitors are not confined to one, but may send any number of competitions.

The correct name and address of the sender *must* be distinctly written upon every competition, not necessarily for publication. Competitions can appear under a *nom de plume*.

☞ We cannot undertake to be responsible for any MSS. sent to us, though when stamps are enclosed for the purpose we will endeavour to return rejected contributions.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

IRON MANUFACTURE.—Required, particulars of the Husgafel process of making iron blooms direct from the ore.—F. C.

COST OF M.S. AND L. RAILWAY.—Can anyone inform me what was the cost per mile of the M.S. and L. Railway from Manchester to Grimsby?—LOW DROP.

RAIL CROSSINGS.—Given the gauge and the angle of crossing of rails, what rule is generally adopted to obtain the radius of the curve and the rails?—R. A. J.

DYNAMITE.—Why does dynamite, when it explodes, penetrate farther and with greater force into a stone (or other substance) in a downward direction than gunpowder?—T. D.

ENGINEERS' WAGES.—Would any reader kindly give me some information as to the wages at Cape Colony and Mexico for mechanical engineers?—REGULAR READER OF "THE MECHANICAL WORLD."

METALLIC PAPER.—Could any reader inform me how paper can be prepared for taking indicator diagrams upon, with brass or iron point, to give a clear erasure with the slightest pressure?—M. H. M.

RUST JOINTS.—How can I stop leakage in a vertical joint (rust joint) in my hot-water pipes (low-pressure system) without cutting out the packing? Would any fluid cement percolate into the crevices and harden there?—B.

MAKERS OF BUILDERS' IRONWORK.—Can any reader furnish me with addresses of firms who are makers of machinery for making builders' ironwork, such as bands and hooks, cavity irons, etc.?—SMITH.

PUMPING PLANT.—Thanks to Mr. Hopkins for reply to pumping plant in last week's journal. Would he kindly say what he thinks would be the cost per day to do the same amount of work with oil engine of, say, best make?—J. P.

POWER RENTAL.—I am desirous of supplying steam power to a tenant from an engine driving his own works. How is the value of such to be ascertained, and what is the fair price for 100 I.H.P. per week of 54 hours; also for 8 I.H.P. similarly supplied power?

ELECTRICAL RESISTANCE.—Can any reader give me any information relative to the resistance offered to the passage of electricity by carbon rods and platinium wire? Is there a small work published on the subject? If I had formula, I could work out myself.—CARBON.

ELECTRIC TROLLEY.—I am in want of a trolley to carry about 3 tons a short distance on a good road nearly level. Can I get one to be self-propelling, and what would be the best kind of motor? I shall be glad if any reader can inform me where anything of this kind can be seen—CORN MILLER.

ELECTRICAL TRAP.—Can any reader of THE MECHANICAL WORLD inform me how to make an electrical trap for catching snakes, reptiles, etc.? I believe they are working successfully in India. Could I make one by enclosing a space and running bare wires round it, and charge by battery?—GEORGE PERKINS (North Queensland).

CONVEYING DEVICE.—I want to remove cut straw, ⅜in. long, from chaff cutter to a room distance 60ft., round one curve, at the rate of 5 tons per hour. What size tube shall I require, and how can I do it by means of a blast fan so that the chaff does not go through the fan? Would sanitary tubes do for the purpose, underground?—PUZZLED.

TUBBING.—What system ought to be adopted in the renewal of tubbing in a shaft which has become faulty in the middle of a length of tubbing 25 fathoms from the surface. Pit 15ft. and 100 fathoms deep? Kindly explain what method to use to secure the greatest safety and make the most permanent work.—J. M.

FACING SLIDE VALVE FACES.—I require a hand appliance, not expensive, suitable for getting up the faces of slide valves of portable, traction, and other engines, say when the valve face is some 3in. to 5in. from the valve-chest cover face. Are there no small hand-lever appliances which can be screwed on to a stud and used for working a broken file or similar tool?—NESCIENCE.

WASTE CLEANING, ETC.—(1.) I shall be much obliged for any information regarding the washing and cleansing of used waste and the filtering of oils; also the machinery necessary for same, cost, etc. (2.) The machinery involved in the grinding of bones to ash for chemical purposes, etc., or most economical way of doing same by furnaces, etc.; the cost of plant, etc.—A. F. L., South Africa.

DYNAMO SHAFT.—I should be much obliged if the author of "The Design and Construction of Stationary Engines," or some other reader, could give me a formula (or refer me to any book where I could find it) for arriving at the size of shafts for dynamos and motors; given distance between bearings, weight of armature and pull on periphery of same in lb. Any information with respect to this would be much appreciated.—A YOUNG ELECTRICAL ENGINEER.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

SHEARS.—Yes, if other things remain the same.

STUDENT.—It is no doubt a misprint, as you suggest.

R. A. CAMERON.—Low and Bevis's "Machine Design," 7s. 6d., is likely to suit you best.

VILLA.—You do not give the cut-off, without which we cannot answer your query.

WATNA.—"Unwin's Machine Design," Part II.

SCREW.—We think we shall be able to procure a copy for you.

CLOCK JOHN.—You would not get the same effect, as you do not obtain instantaneous condensation.

CARDIFF.—Your greatest difficulty will be to persuade the railway companies to adopt your valve.

APPRENTICE.—The same method is used as with steam-engine diagrams. We hope to insert an article shortly on the subject.

D. A. J.—There is no space in the query column for such sketches as you require. We do not know what planing machine you refer to.

SPARK.—Your query is obviously an advertisement, and can therefore only be inserted in the portion of the journal in which these appear.

COKE OVENS.—Will any reader of THE MECHANICAL WORLD give me particulars for erecting coke oven plant—viz., beehive ovens? Also particulars of flues for the erection of steam boilers to raise steam from the waste gases from ovens; or state the best works on the above?—COKER, J. C. S.——*A.*—The best form of coke oven is that which admits of the gases being saved and their bye-products extracted before using. Apply to the Mercantile Gas and Coke Company, 5, Guildhall Chambers, London.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

3rd March, 1893.

4667 ADJUSTABLE SPANNERS. T G Juckes. (*A P Juckes*, Ceylon.)

4673 APPLIANCES for TEACHING DRAWING and GEOMETRY. H D Barkas.

4674 RAILWAY WAGON COUPLINGS. C Leischer.

4677 SOLDERING of ALUMINIUM. A C Fel.

4679 GUIDE and TIGHTENING DEVICE for DRIVING BELTS. W W Horn. (*W F Cleveland*, Canada.)

4682 MACHINES for CUTTING and BENDING SHEET METAL. W J Bayrer.

4684 BOILER TUBES, FLUES, and the LIKE. D Purvis and J G Garrick.

4685 RECORDING and REPRODUCING TAPES for ELECTRICAL TICKER MACHINES. J E Bott.

4686 OIL-FUEL REGENERATIVE FURNACES. J E Bott.

4690 LUBRICATORS. R F Yorke.

4691 PRODUCTION of ELEMENTS for SECONDARY BATTERIES. The Lithanode and General Electric Company Limited and J T Niblett.

4694 MEANS for the MANUFACTURE of TOOTHED RACKS. W P Grafton.

4696 GAS and OTHER INTERNAL COMBUSTION ENGINES. D Davy.

4th March, 1893.

4703 REDUCING and REGULATING VALVES. C H Prött, jun.

4705 RESISTANCE GOVERNOR for MARINE or OTHER ENGINES. G F Alder and E Rayner.

4719 LOWERING and DETACHING GEAR for LIFEBOATS. T Murphy.

4722 HYDRAULIC PISTON PRESSING and FORCING TOOLS. J Robertson.

4724 MEASURING and INDICATING DEVICES.* R Meyer.

4729 MINERS' SAFETY LAMPS. T Thomson.

4730 THE MEASURING of ELECTRICITY. R Kennedy.

4734 ELECTRIC FOG SIGNALLING and the BETTER PREVENTION of ACCIDENTS by COLLISION on RAILWAYS. S G Kirk.

4746 INCANDESCENT ELECTRIC LAMPS.* O Imray. (*T D Bottom*, United States.)

4754 PUMPS. G Hughes. (*G W Bartholomew*, United States.)

4759 ELECTRICAL RESISTANCES. W M Meredith.

4764 AXLE JOURNAL and WRIST-PIN BOXES. W P Thompson. (*W L Eveland and H Stephens*, Canada.)

4772 INSULATING and PRESERVING METAL ARMS USED for SUPPORTING ELECTRIC TELEGRAPH INSULATORS. T G Marsh.

4775 FUEL ECONOMISERS or FEED-WATER HEATERS. J G Cawert.

4776 AUTOMATIC PNEUMATIC FOG SIGNAL. L Summerfield.

6th March, 1893.

4793 REEL and BATTERY BOX in CONNECTION with PORTABLE ELECTRIC BELLS. J O Brooke.

4794 METALLIC TUBES, CYLINDERS, HOLLOW WHEEL RIMS, GUN BARRELS, ETC. B and G Shorthouse.

4795 REVOLVING LIGHT for SHIP SIDES, DECK HOUSES, ETC. J Shaw.

4799 SHAFT GOVERNORS for STEAM ENGINES. W E Lilly and W H Callwell.

4804 SHAFT COUPLINGS. A Guild and Barry, Henry and Co. Limited.

4806 HEATING RAILWAY CARRIAGES by MEANS of HOT WATER and STEAM PIPE COILS. J and J P Cochrane.

4807 APPARATUS for LOCKING DOORS of RAILWAY CARRIAGES. J and J P Cochrane

4818 ELECTRIC LIGHT SWITCHES and CUT-OUTS.* C M Dorman and R A Smith.

4824 PURIFICATION of SEWAGE. G Webb and others.

4826 APPARATUS for USE in GALVANISING TUBES, RODS, and BARS of IRON and STEEL. H H and C S Brand.

4827 ELECTRIC ALARM for AUTOMATICALLY SIGNALLING when LUBRICATORS are EMPTY. J Pollit and others.

4831 APPARATUS for FOG SIGNALLING on RAILWAYS. J Wilkinson.

4832 TRANSMITTING MOTION to SCREW PROPELLER SHAFTS. A A Lebreton.

4834 STEAM TRAPS.* E H Gold.

4840 PETROLEUM ENGINES. A J Boult. (*The Firm of A G Barends*, Germany.)

4841 POINT LOCKS for RAILWAYS. C Hodgson.

4842 CENTRIFUGAL GOVERNOR OPERATING with LIQUID. J I Rüsch and O Sendtner.

4843 ARTIFICIAL FUEL. T Macneill.

4852 CONDENSERS.* W E Dennis.

4858 SHIPS' DAVITS. J Knox.

1859 WHEEL MOULDING MACHINES. J Pride.

4861 APPARATUS for IMPARTING TRACTION POWER to VEHICLES when STARTING. R Haddan. (*F P Garzia*, Italy.)
4867 LIFT. T Marker.

7th March, 1893.

4870 PREPARING for USE PIGMENTS CONTAINING OXIDE of ZINC or OTHER OXIDES or SALTS of METALS. A P Laurie.
4871 ELECTRIC BATTERIES. N Rolland.
4873 MACHINERY for FORCING AIR or OTHER GASES. J C R Oakes and W T Goold.
4874 TRANSFORMING and CONVERSION of ELECTRIC CURRENTS. H F Foster.
4878 SAND VALVES. G H Byrd.
4879 SPEAKING TUBE EXCHANGE.* L Strouse.
4880 PORTABLE RAILWAY SWITCHES.* J E Norwood.
4883 COMBINED FEED-WATER HEATER and CONDENSER. R Henderson.
4887 COATING IRON and STEEL with BRASS and OTHER METALLIC ALLOYS. A V C and J B Fenby.
4891 LUBRICATING AXLES and SHAFTING. G H Byrd.
4894 COUNTERS and INDICATORS. W A M Brown.
4895 GAUGES for SHOWING the WATER LEVEL in STEAM BOILERS.* J Lumb.
4896 DEVICE for JOINING the EDGES of DRIVING BELTS. S Cook.
4898 SLIDE WAYS.* G Refardt.
4899 SPANNERS and WRENCHES. T Baines, jun.
4904 ATTACHMENT for TAPE MEASURES.* W O Sheppard.
4909 DIVIDERS. A Hughes.
4910 ELECTRIC SWITCHES.* E L Joseph and others.
4911 CONTACT MAKERS for ELECTRIC LAMP HOLDERS.* E L Joseph and others.
4912 SPRING BUFFER CONNECTIONS for the HOLDERS of ELECTRIC LAMPS. E L Joseph and others.
4913 SIGNALLING APPARATUS for RAILWAYS. J Y Johnson. (*E Marin*, France.)
4914 SWITCH. G Graham and A J Petchey.
4917 ROTATING CYLINDER ENGINES.* S G Brosius.
4923 CONDUCTORS in TELESCOPIC STANDARD LAMP HOLDERS.* A G New.
4928 RAIL JOINT for RAILWAYS.* S F Stever.
4938 INCANDESCENT ELECTRIC LAMPS. G S Ram.
4941 SIGNALLING on RAILWAYS. J Tuma and E von Motesiczky.
4944 BELTING or POWER TRANSMITTERS.* E Todd.
4947 STOP VALVES. J A and J Hopkinson.
4949 INJECTORS.* A Myall. (*The Hancock Inspirator Company*, United States.)
4952 ELECTRICAL RELAYS and MEASURING INSTRUMENTS. W S Smith and W P Granville.
4953 SHAFT COUPLINGS.* H H Westinghouse and W A Bole.
4967 MOUNTING of FLY-WHEELS and OTHER HEAVY BODIES on ENGINE SHAFTS.* E Seger.
4975 IRON and STEEL WHEELS. P Arbel.
4976 APPARATUS for WORKING RAILWAY SWITCHES by MEANS of ELECTRICAL ENERGY. Siemens Brothers and Co. Limited. (*Messrs. Siemens and Halske*, Germany.)

8th March, 1893.

4092 ELECTRIC LAMP SOCKETS. H Hirst
4999 APPARATUS for MAKING CASKS. A Dunbar.
5000 MACHINERY for FINISHING STAVE BLANKS for CASKS. A Dunbar.
5005 DEVICE for PREVENTING the BURSTING of GAS ENGINE and OTHER WATER-JACKETED CYLINDERS by the FREEZING of the WATER. E Rollason.
5006 GAS ENGINE GOVERNORS. E Rollason and T B Barker.
5010 PETROLEUM ENGINES. J Trewhella.
5011 GAS and PETROLEUM ENGINES. J Trewhella.
5020 APPARATUS for COUPLING and UNCOUPLING RAILWAY WAGONS. S Hamer.
5022 FORMING JOINT FLANGES on COPPER PIPING. J C Black.
5029 METHOD of CONSTRUCTING the PERMANENT WAY of RAILWAYS or TRAMWAYS. W B Armstrong.
5038 APPARATUS for CONTAINING and SUPPLYING LIQUID INDIAN INK, WRITING INK, ETC. H L Nikel.
5045 GOVERNOR EXPANSION GEAR. J Meredith.
5051 PRIMARY BATTERIES. T Coad.
5053 GENERAL JOINERY MACHINES. J Anderson.
5055 FOG SIGNALS or DETONATORS. H F Clark and J P O'Donnell.
5056 MACHINES for BENDING, EDGING, and FOLDING the EDGES of SHEET METAL. D Smith, jun.
5070 INDICATING APPARATUS for SCREW-CUTTING LATHE. H G Marshallsay and T Richardson.
5076 FRET-SAWING APPARATUS. J Noble.

9th March, 1893.

5087 WIND MOTORS. W J S Barber-Starkey.
5091 STEAM ENGINES. J Lever and M W Mills.
5093 APPARATUS for AUGMENTING the POWER or EFFICIENCY of GAS MOTOR ENGINES. F B and W Howarth.
5097 ROLLS of ROLLING MACHINERY. A Blackwell.
5101 ELECTRICALLY INTERLOCKING SIGNALS and POINTS. G E Fletcher.
5103 SECTION of IRON or STEEL BARS, PILLARS, or RODS. W Harvey.
5109 COUPLING ALTERNATING CURRENT DYNAMO-ELECTRIC MACHINES in SYNCHRONAL RELATION. W Lowrie.
5110 APPARATUS for CHARGING ELECTRIC ACCUMULATORS. W Lowrie.
5112 WASHERS for LOCKING SCREWED NUTS on or to SCREWED BOLTS. H W Townsend.
5113 DOVETAILING CUTTER and SLOTTING TOOL. W Henshall.
5115 FURNACE BARS and OTHER FIRE BARS.* J W Goodreds.
5117 HOLOSTERIC BAROMETER. E Biebisch.
5122 STEAM BOILERS.* R Scott.
5123 COUPLING and UNCOUPLING RAILWAY ROLLING STOCK. J Cartwright and J Vickerstaff.
5127 TAPS or COCKS. P Roberts and T L Bullworthy.
5142 INCANDESCENT ELECTRIC LAMPS. Sir C S Forbes, Bart.
5143 MICROPHONES. Sir C S Forbes, Bart.
5145 NON-EXPLOSIBLE MULTITUBULAR BOILER. B J B Mills. (*A Coignet*, France.)
5149 SCREW PROPELLERS and PROPELLING APPARATUS for SHIPS. R G Foot.
5155 PROPELLERS for SHIPS. E M Canneaux.
5157 STEM GUIDES of STAMP BATTERIES. C Raleigh.
5159 SEPARATING METALLIC from NON-METALLIC SUBSTANCES. C Raleigh.
5160 SEPARATING METALLIC from NON-METALLIC SUBSTANCES. C Raleigh.
5161 STAMP BATTERIES and PULVERISING MACHINES. C Raleigh.
5162 SCREENS or SIEVES for USE in STAMP BATTERIES. C Raleigh.
5163 TREATMENT of SLIMES or FINELY-DIVIDED ORE CONTAINING PRECIOUS METALS. C Raleigh.
5171 ELECTRIC SAFETY LAMP. D Tommasi.
5175 HEAD LIGHTS.* F G Mylrea. (*George Washington Jacobs*, United States.)
5181 COMBINED LAMP and ELECTRICAL IGNITING DEVICE THEREFOR. J Lang.

10th March, 1893.

5193 CUTTING TOOLS. E Smith.
5199 GAS PRODUCERS. J Hargreaves.
5211 COMBINED CONDENSER, FEED-WATER HEATER, FILTER, and AIR EXTRACTOR for STEAM GENERATORS. J McPherson and W J H Adam.
5214 SAFETY ELECTRIC MOLTEN LOCK for MINERS' LAMPS.* O Hawkins.
5223 SMELTING FURNACES. L W Broadwell.
5228 INSTRUMENT for DRAWING or CAUSING the POINT of ANY TOOL to DESCRIBE ANY CONIC CURVE. J A Gillett.
5230 ANTI-FRICTION BALL BEARINGS for AXLES, SPINDLES, and JOURNALS of ALL KINDS. A J Boult. (*G Neale*, United States.)
5235 AUTOMATIC HAULING or DRIVING FORKS for ROPE or CHAIN HAULAGE. M Garthorne.
5236 FUEL CHAMBERS of FURNACES. R Marshall.
5237 GAS REGULATORS. G F Redfern. (*John Duncan*, Canada.)
5238 FURNACE ROOFS. J E Bott.
5240 APPARATUS for REPRODUCING FAC-SIMILE CARVINGS in WOOD.* C Hass.
5245 VICES.* M Jaeger.
5248 IMPROVEMENTS RELATING to the BLAST of MULTITUBULAR BOILERS. J Armstrong.
5251 RELEASING GEAR APPLICABLE to CORLISS or OSCILLATING CIRCULAR and OTHER VALVES. A G Brookes. (*L I Seymour*, South Africa.)
5256 GAS PUMPS. H H Lake. (*T Beckaljau*, Belgium.)
5257 LEVEL for USE in MEASURING ANGLES.* L A D Montague.

11th March, 1893.

5267 STEAM TRAPS. G J Churchward.
5271 APPARATUS for MAINTAINING the TENSION of or COMPENSATING for the EXPANSION and CONTRACTION of SIGNAL or LINE WIRES. A E Berry.
5282 APPARATUS or GEAR for REVERSING and OPERATING SLIDE or OTHER VALVES with a SINGLE ECCENTRIC. E M Sheppard.
5285 TAP VALVES. J Cartlidge.
5286 APPARATUS for TRANSMITTING and REPRODUCING SOUNDS. T Dedolph.
5288 DRILLS. A Pickard.
5289 EXHAUST SCRUBBER for PETROLEUM and OTHER MOTORS. J Walker.
5290 INDICATORS for ASCERTAINING the POWER of STEAM and OTHER ENGINES. M J Waynf.
5294 PUMPS.* C L Hett.
5297 FITTING STERN TUBES in SCREW STEAMSHIPS for PROTECTING the PROPELLER SHAFT from CORROSION CAUSED by the ACTION of SEA-WATER. J F Kitching and R Coulson.
5308 WOOD SCREWS. C A Jones.
5310 INDICATORS for COMPOUND and MULTIPLE-EXPANSION ENGINES. F Kovarik.
5314 WATER WHEELS. C Taber.
5324 HYDRAULIC TOOL for CUTTING OFF RIVET HEADS. T Blenkinsopp and J W Parker.
5327 PROCESS for COATING or PLATING NON-METALLIC ARTICLES WITH METAL. T M Ash and others.
5328 COCKS, TAPS, and the LIKE. A J Boult. (*R Claassen*, Germany.)
5329 AMMONIA or OTHER LIKE ENGINES. F Küttel.
5331 APPARATUS for SAWING or CUTTING STONE, METAL, or OTHER HARD SUBSTANCES. A J Henderson.
5337 CONDUCTORS for ELECTRIC RAILWAYS. J A Ewing.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to SIR H. READER LACK, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

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FRIDAY, MARCH 31ST, 1893.

The New Coaling Station at Portsmouth.

THE importance of providing special means for the rapid coaling of our men-of-war has been repeatedly urged from time to time, but it is only within the last few years that any serious attempt has been made by the Admiralty to supply the obvious defect in our naval organisation. The method hitherto adopted in coaling the fleet at the principal ports has been by means of sacks and baskets, a process which was not only laborious but extremely slow, and which might in a time of war prove disastrous. The recognition of these facts led the Admiralty to form coaling stations at Portland and Portsmouth, and to provide them with the most modern appliances. The Portsmouth station, which is now practically complete, and has a capacity of storing 50,000 tons of coal in a pile 10ft. high, has been formed on a point of land on the northern side of the Tidal Basin, having a large water frontage. The plant, which is designed both for receiving and discharging coal, consists of two large pairs of compound surface - condensing engines, two accumulators, ten hydraulic 30cwt. elevated cranes, constructed for trucks to pass under them, two coal hoists, and a number of hydraulic capstans and accessories. The cranes and hoists are worked by hydraulic power from mains at a pressure of 700lb. to the square inch, and are connected with hydrants by means of telescopic tubes having a range of 10ft. in any direction. Each crane has a span of 50ft., turns on a pivot, and can be moved from place to place on lines of rails by a winch and gearing. While the cranes will be exclusively employed in loading and discharging sea-borne coal, the hoists will be used for filling ships rapidly with land-borne coal during periods of stress, when colliers may not find it possible to navigate the sea. In this case the coal wagons will be lifted bodily upon the platforms of the hoists, tipped by means of hydraulic cylinders, and their contents, weighing 10 tons, discharged down shoots into cruisers and lighters. Each hoist is understood to be able to load with loose coal at the rate of 500 tons an hour. It is believed that each crane can load and discharge at the rate of 50 tons an hour. Of course, only cruisers and comparatively small armourclads will be able to load with coal alongside. Battleships will have their supplies conveyed to them by lighters, which, for the sake of quick and convenient handling, will receive the coal from the cranes in bags. The Portland station is not yet completed.

Telegraphing between Moving Trains.

A SERIES of experiments have been conducted in Algiers by French engineers, with a view to practically test a system of telegraphic communication between trains in motion and railway stations. The experiments were made (1) to telegraphically connect a moving train with the station; (2) to exchange messages between two travelling trains; (3) to telegraph to the driver of a train to stop the latter and return to the station; and (4) to stop and prevent a collision between two express trains travelling towards each other from opposite directions on the same line. The experiments, made under the superintendence of the inventor, M. Etienne, are said to have been highly successful, but no information is forthcoming as to the details of the system used. It is probable that the line was used for the transmission of the messages; but this is not new, as similar experiments have been made in this country on various occasions.

The American Tinplate Trade.

FROM a report issued by Col. Ayres for the quarter ending December 31, 1892, it appears that during the quarter 32 firms produced 19,756,491lb. of tin and terne plates proper. The same number of firms produced during the previous quarter 10,952,725lb. Of the production of the past quarter 6,138,739lb., or a little less than one-third of the whole, were bright tinplates, of which 5,274,434lb., or about 86 per cent., consisted of the class of plates weighing lighter than 63lb. per 100 sq. ft.; 13,617,752lb. were terne plates, of which 12,684,646lb., or more than 93 per cent., belonged to the lighter class; of the entire product nearly 91 per cent. consisted of the lighter class of plates. The amount of American sheet iron and steel made into articles and wares tinned or terne during the quarter, as shown by the sworn statements of manufacturers received to date, was 2,245,506lb., and for the previous quarter 898,233lb. This makes the total production for the last quarter, within the meaning of the law, 22,001,997lb., against 11,850,958lb. produced during the quarter ended September 30, 1892, and shows a total production for the six months ended December 31, 1892, including the products from American sheet iron and steel tinned, of 33,852,955lb. In this connection it may be said that a report has also been issued from the Foreign Office, prepared by Mr. Michael M. Herbert, First Secretary to the British Legation at Washington, who arrives at the following conclusions:—1. That the promises of the promoters of the tinplate schedule of the M'Kinley Act have not been fulfilled. 2. That little American tinplate of any kind has hitherto been offered on the market commercially. 3. That, if Colonel Ayres' figures are correct, the American consumer has had to pay, roughly speaking, about 1 dollar per box extra in duties for every tinplate manufactured. 4. That the M'Kinley Act has advanced the price of tinplate about 1 dollar per box. 5. That it has damaged the canning industries of the United States. 6. That it has stimulated the importations of black plates ready for tinning. 7. That imports of tinplates from the United Kingdom have not in reality fallen off, as has been stated, but even now show signs of increasing.

Naval Progress.

IN the course of his inaugural address before the Institution of Naval Architects last week, the Earl of Ravensworth expressed the opinion that he could not congratulate naval architects on the business of the year. There was a great deal of truth, he observed, in the saying that bad times were frequently fruitful in improvements, and the experience of the past year entirely confirmed that saying, the improvements being largely brought about by the necessity for economising navigation. It was a matter for congratulation that the Admiralty were rapidly completing the magnificent fleet which had been in course of construction since 1889, and that a continuous policy of shipbuilding was to be pursued. Another interesting point was that our marine engineers were in a fair way to meet and overcome the difficulty experienced with the boilers, and to which reference will be made in a subsequent issue. As an instance of the material of which our vessels are made, he instanced the "Apollo," which received very serious damage to her hull, and yet did not founder. Then, again, the repair of the propeller shaft of the "Umbria" in the Atlantic, 800 miles from shore, was a noteworthy incident, reflecting great credit on the engineering staff of that vessel. His lordship next mentioned that a remarkable vessel, which was expected to steam 27 knots, was being built at Belfast. She was to be fitted with three screws, and with engines aggregating 45,000 H.P. That was almost incredible; but it was expected that the vessel would cross the Atlantic in the short space of four and a half days. It really seemed, remarked the speaker in concluding his address, as if the mighty Atlantic, which was the dread of navigators not many years ago, was to be converted into an experimental tank in which the speeds of the great ships that various competing maritime nations were building might be tested.

Death by Electricity.

BEFORE the Société de Biologie in Paris, M. d'Arsonval recently delivered the conclusions of work done partly by M. F. Biraud at the laboratory of M. Lacassagne at Lyons, on the subject of death and accidents caused by high-tension electric currents. The work forms the first complete monography published on the question, thanks to the inquiries made by MM. Lacassagne and Biraud of electricians throughout the world. M. Biraud's gives a full description of accidents due to shocks received by those engaged in the electrical industries, an account of electrocutions carried out on men and animals in the United States, and mention is made of some of his personal experiments. The conclusions drawn from these observations coincide with those which M. d'Arsonval formulated in 1887. As a whole, electricity appears to kill in the two following ways: (1) By producing mechanical lesions of the vessels and the nervous system; and (2) by stopping the principal functions, such as the stoppage of respiration and of the action of the heart, etc. In the first case, death is above all due to the action of lightning and static discharges from powerful batteries. From a practical point of view these two methods are distinguished from one another in the sense that the first causes positive death, whilst the second brings on a state of apparent death from which the person may be brought again to consciousness by practising artificial respiration immediately after the accident, otherwise actual death may ensue. A person who has been struck by lightning or otherwise received a shock should, according to M. d'Arsonval, be treated exactly as one drowned, and the application of this principle has been the means of saving a certain number of lives since it was formulated. As far as electrocution is concerned, MM. d'Arsonval and Biraud regard it as a complicated and barbarous proceeding. The former had Gramme machines placed at his disposal in 1888, giving 8000 volts, and which could not be depended upon to surely kill, whereas in the States a current at 1500 volts only was used for electrocution. He had challenged American physicians to dare to attempt artificial respiration after the electrocution of a prisoner, but they had not accepted the challenge, and had even at once hastened the autopsy. This, it is contended, showed that autopsy was a necessary adjuvant to electrocution.

Bullet-proof Uniform.

WE really do not know what to make of the reports published in the English papers, from German accounts, of the alleged invention of a bullet-proof uniform by a tailor named Dowe, of Mannheim. It is not a complete uniform, but a kind of cuirass or breastplate for the body. Externally the new garment when made presents the appearance of ordinary army clothing material. The resisting substance, the composition of which the inventor, of course, keeps secret, is placed underneath. The breastplate weighs 6lb., and is easily attached to the uniform. This so-called bullet-proof uniform has been tested on a life-size dummy by German military officers, at distances ranging from 100 to 400yds. The shots which hit the mark are said not to have passed through the resisting material, the bullets, which were coated with steel, being rendered quite flat by the resistance offered to them —at least, according to the reports. The experiments, in the words of Professor Billroth, would have been more satisfactory if Mr. Dowe had worn the jacket and allowed himself to be shot at. However, Mr. Dowe is said to have been anticipated three years ago by K. Scarneo, an Austrian, who invented a similar coat-of-mail, but owing to lack of funds he was unable to proceed further with his invention. If it is true that an enormous sum of money has been offered to Mr. Dowe by a firm of army contractors for the possession of his secret, he would have done well to have accepted it. European Powers will not, we venture to think, have recourse to coats-of-mail similar to those worn by the knights of the Middle Ages. Even if the new breastplate were adopted, bullets would doubtless soon be forthcoming to penetrate them.

Mason College Engineering Society.

A GENERAL MEETING of the above society was held in Mason College on Wednesday, the 22nd inst., Professor R. H. Smith in the chair. Mr. J. Watkins read a paper on "The Engineer's Slide Rule." The author gave a short history of the origin of the slide rule, describing the work of Napier, Gunther, Foster, and Routledge in this respect, and then proceeded to give numerous industrial illustrations of the use of slide rules. The paper was followed by a discussion, in which Professor Smith and Messrs. Muirhead, Ballard, Waynforth, and Archer took part, the proceedings terminating in a vote of thanks to Mr. Watkins for his paper.

DURING the half-year ending the 31st of December last, the locomotives of the Midland Railway ran 8,222,166 miles with passenger trains and 12,318,428 miles with goods trains.

Mechanical and Engineering Drawing.—IX.

By a Practical Draughtsman.

Plane Geometry Problems.—As the lines forming the *boundaries* and determining the *forms* of the plane geometrical figures previously described, have a certain relative position, it is necessary. before attempting to construct the figures themselves, that we know how to draw geometrically, lines having any defined relation to each other. As this knowledge is generally imparted in the form of *problems*, with their solutions, we shall adopt the same plan; but in explaining the constructions shall not confine ourselves to any orthodox method of doing so, where a simpler one may be used. The student will remember that in solving the subsequent problems, only the tools mentioned in the latter part of the previous article are to be used, as the assistance of either a drawing board or squares is inadmissible. As it is not always possible to apply a rule, or a scale, to a line when we wish to sub-divide it into parts, our first problem is:—

Problem 1 (Fig. 42).—To divide a given straight line into two equal parts? Now, if the given line is *near the edge* of the material on which it is drawn, a different method of construction must be used to that which would be possible if the line were *some distance from* that edge. In the former case proceed as follows:—With a distance greater than half the length of the given line A B, as a radius, and with A and B as centres, describe arcs cutting each other in C, and with a still larger radius than before, and from the *same* centres describe arcs cutting each other in D; then the point E, where a straightedge laid exactly on C and D crosses the line A B, is the middle of the given line, and divides it into two equal parts. In the latter case, with the distance greater than half A B (which may be gauged by eye) as radius, and from A and B as centres, describe arcs on both sides of the line A B, cutting each other in C and F. Then the straightedge applied to C and F will give E in A B as its point of section, dividing it into two parts of equal length.

Problem 2 (Fig. 43).—At a given point C, in a straight line, to erect a perpendicular? Here the point may be near the *middle* of the line or near the *end* of it. If the former, as at C, in the line A B, and if A B be near the edge of the material, proceed as follows:—Set off from C, on either side of it, equal distances, as C D, C E, and from D and E as centres, with a radius greater than half the distance between D and E, draw arcs cutting each other in F, then a line drawn through F and C will be perpendicular to A B. If the given point is near the *end* of the line and the edge of the material, as A in B D (Fig. 44), then from any point *a*, above or below B D, and with a radius equal to *a* A, describe an arc C A T, passing through A, and cutting B D in T. Draw a line from T through *a*, and produce it till it cuts the arc in C. A line from C through A will be perpendicular to B D at A.

Problem 3 (Fig. 45).—From a given point A, above a straight line B C, to let fall a perpendicular to that line? Here the point may be nearly over the middle, or over the end of the given line. If in the first position, with any radius greater than the distance from the point A to the line B C, describe an arc cutting B C in D and E, and from points D and E as centres, with a radius greater than half the distance between D and E, draw arcs cutting each other in *a* and *b*; then a line drawn through the given point A and the intersections of the arcs in *a* and *b* will be the required perpendicular. If the point is nearly *over the end* of the given line, as *b* in Fig. 46 is over A B, from *b*, draw a line intersecting A B in C, and bisect it in S; with S C as radius and S as centre, describe an arc cutting A B in D, join *b* and D, and the line will be perpendicular to A B. The student will notice that the construction in the second cases of *Problems* 2 and 3 is similar. This arises from the fact that the line drawn to the given point has in each case to be at right angles to the given line, and as the angle in a semi-circle is always a right angle, the problem is to draw a semi-circle that shall contain the three angular points of a right-angled triangle, one of which is the given point in the problem.

Problem 4 (Fig. 47).—To bisect (or divide into two equal parts) a given angle? When speaking of an angle, it is usual to name it by affixing either a single letter at the angular point, or a letter to each of its lines and the angular point, the one denoting the latter being always the second. In the problem, let B A C be the given angle. With any convenient radius set off from A equal distances on B A and C A in the points D and E, and from these points, with a radius greater than half the distance across from D to E, draw arcs intersecting in F; a line through F and A will bisect the angle B A C. This construction, it will be seen, is tantamount to bisecting a line from D to E, and drawing a line through its bisection and point A, the only requisite condition being that the two points D and E in the lines forming the angle must be equi-distant from the angular point A.

Problem 5 (Fig. 48).—To draw a line parallel to a given line at a given distance from it? Here it is evident that if from any two points C and D in the given line A B, arcs be drawn, of a radius equal to the given distance the two lines are to be apart, and a line E F be drawn tangent to those arcs, then the line E F will be parallel to the given line A B. This is the simplest possible solution of the problem,

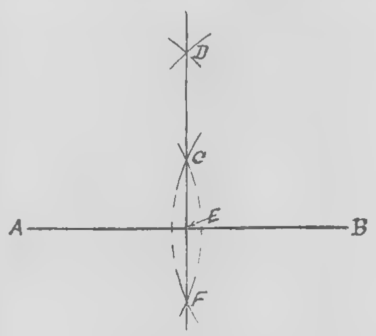


Fig. 42.

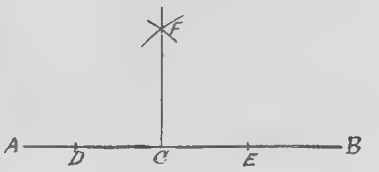


Fig. 43.

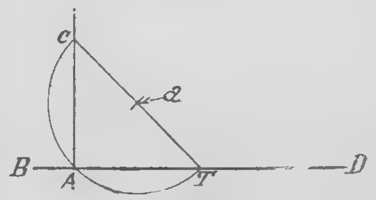


Fig. 44.

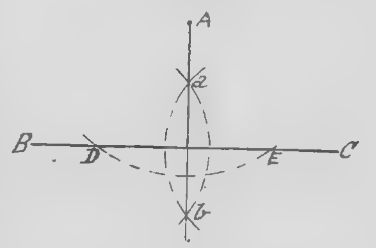


Fig. 45.

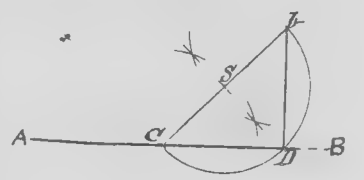


Fig. 46.

involving the least work, but requires care in drawing the parallel line exactly tangent to the arcs. Another solution requiring much more work in the construction, is the following:—At the points C and D, in line A B (Fig. 48), erect two perpendiculars to A B, and set off on each of them from C and D the distance the parallel lines are to be apart. Through the two points obtained draw a line, and it will be parallel to the given line A B.

Problem 6 (Fig. 49).—Through a point P, to draw a line parallel to a given line A B? With P as a centre and any convenient radius, describe an arc E C, cutting the given line A B in C, and from C as a centre, with the same radius, draw an arc through P, cutting A B in D. Set off the distance P D on the arc E C, and through P and E draw a line; it will be parallel to the given line A B.

Problem 7 (Fig. 50).—To draw an angle equal to a *given* angle A? This means that two lines are to be drawn having the *same* inclination to each other that two *given* lines have. We must therefore first find the inclination of the given lines. To do this we have only to draw on the *given* angle an arc of any convenient radius, with A as centre, such as B C. The length of its *chord* is the distance subtended by the lines forming the angle at the radius A B or A C. If, then, from point *a*, in the line D E, and with a radius equal to A B, we describe an arc *b c*, and from *c* set off a distance on *b c* equal to the chord of the arc B C, then a line drawn through *b* and *a* will make the same angle with D E that A B does with A C in the given angle, which solves the problem.

Problem 8 (Fig. 51).—To draw a line making a given angle—say, 60°—with a given line? The solution of this problem involves the relation that the radius of any circle has to the chord of an arc which subtends an angle of 60° in the circle. To solve it, let A B be the given line, and C a point in it at which it is desired to draw a line making an angle of 60° with A B. From C, as centre, and with a convenient radius, draw the arc D E, cutting A B in E; from E with the same radius cut D E in D, then a line drawn

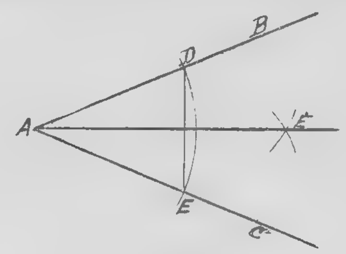


Fig. 47.

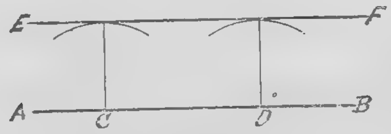


Fig. 48.

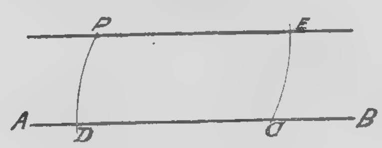


Fig. 49.

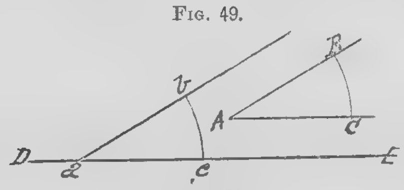


Fig. 50.

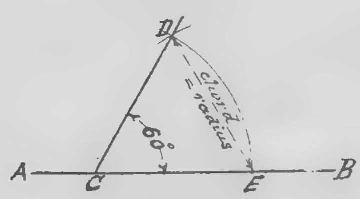


Fig. 51

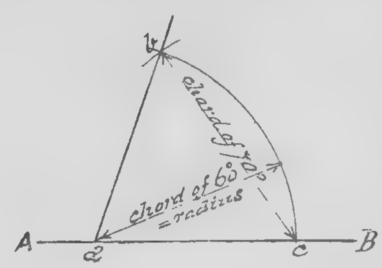


Fig. 52.

through D and C will make an angle of 60° with the line A B. If the circle were completed with the same radius, it would be found, on stepping the radius round it, that it exactly divides it into *six* equal parts, and as every circle for geometrical purposes (as before explained) is divided into 360°, one-sixth of the circle must contain 60°, or the angle which the two lines in the problem have to make with each other. Knowing this specific relation subsisting between the radius and the chord of an arc of 60° of a circle, we are enabled to lay down any angle with the assistance of a "scale of chords," which will be found on one of the set of drawing scales previously recommended. To show its use, let us take, for example,

Problem 9 (Fig. 52). — To draw a line, making an angle of, say, 70°, with a given line at a given point in it? Let A B be the given line, and *a* the given point in it. From the zero point, on the *extreme left* of the scale of chords, and with a radius in the compasses equal to the distance from that point to the one marked 60—with the arrow over it—on the scale, draw with *a*, on the line A B as a centre, the arc *b c*, cutting A B in *c*, and from *c* as a centre, with a radius equal to 70° on the scale of chords, cut the arc *b*, *c* in *b*. A line drawn through *b* and *a* will make, with the given line A B, an angle of 70°; and so with any other angle, always remembering that from *zero to 60* on the scale of chords is the radius with which the first arc in the construction is to be drawn.

(To be continued.)

A New Electric Tool.

The use of electricity has enabled mechanical power to be applied in a great number of cases where without it hand power only would be practicable. One of the latest applications of electric current for this purpose is an electric deck planer, invented by Mr. Malcolm Sutherland, electrical engineer to Wm. Denny and Bros., the well-known shipbuilders of Dumbarton, a firm who are always well to the front in adopting improved methods of working. The machine, as made and used by them for planing the decks of ships built in their yards, is exceedingly simple in construction, and resembles a lawn mower in form, being handled in the same way, and it is stated with as much ease. A steel baseplate is mounted on rollers, and to the underside of this the revolving cutter is attached, whilst the electric motor is placed on top and geared to the cutter by spur wheels, which are covered by an iron guard. The front roller is of the same length as the cutter, so that in passing over the deck it lies on the crests of the uneven parts of the deck and keeps the machine practically level. The hind rollers are set in so that they follow in the wake of the cutter. The machine is fitted with eccentric bearings, and by moving a lever they can be raised or lowered, thus making the cut greater or less as required. The results obtained are very satisfactory, as it is a great advance on hand work so far as regards time, while it relieves the men of a very disagreeable job, as deck planing by hand involves kneeling or sitting on the deck in a most uncomfortable position. The machine is ingenious, and will doubtless be generally used for the particular purpose named.

Manchester Association of Engineers.

The members of the Manchester Association of Engineers, at a meeting held at the Grand Hotel, Manchester, on Saturday, the 25th inst.—Mr. Thomas Daniels, the president, in the chair,—resumed the discussion of a paper recently read by Mr. C. R. Iorns on "The Relations between Employers and Workmen in Engineering Works."—The President, in reopening the discussion, said that with regard to the experiment that had been begun at the works of Messrs. Mather and Platt, he observed that Mr. Mather said he did not wish to do anything to hurt his neighbours; but he had never heard that Mr. Mather consulted his neighbours before doing what he had done. We were told that a man could do what he liked with his own; but he could only do that when what he did did not hurt his neighbour. He had heard it said that since the new system was adopted the gates of Messrs. Mather and Platt's works were closed two minutes before time, so that the men had to be in by that time and ready to start exactly on the dot.

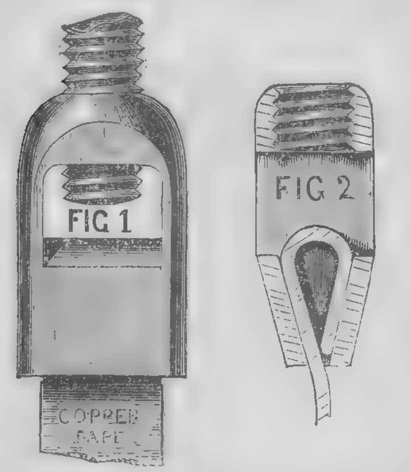
Mr. Thomas Ashbury referred to the dispute in the cotton trade as illustrating that, although there was still too much friction between employers and employed, a great improvement had been effected in the manner in which the disputes were carried on—there had been none of the violence which at one time attended such quarrels. With regard to the experiment at Guise, in France, to which Mr. Iorns had referred, it struck him as being rather remarkable that that illustration of co-operation had not been copied to any great extent. As to the 48 hours system, he did not believe in it, and he quite agreed that such a reduction of hours was not essential to the full development of the mental, moral, and physical qualities of a working-man. The discussion was continued by Messrs. Rae, West, and Webb. Mr. James Swift (secretary of the Steam Engine Makers' Society) remarked that it was said that the engineer was in a better position than he had ever been before; but as a matter of fact he was no better off than he was 20 years ago. The rate of wages was the same now as in 1871, and the men were no better off, except that they worked an hour less. So he thought it could not be said that they had not shown fair consideration to the employers. They believed, however, that they could gain more by diplomacy than by brute force, such as was preached at the street corners to-day. With reference to

the inequality of wages to which reference had been made, the various trade societies had used their utmost efforts to bring up the localities that had been referred to, to the medium rate. In the Yorkshire district large sums of money had been spent in trying to get the men into the unions and so force up the rate of wages. With regard to the hours of labour, he did not think that, so far as the engineering trades were concerned, they would have a legal enactment for some time to come. At the same time he had no doubt the men were ripe for shorter hours, and if they did not get them voluntarily they would, by-and-bye, attempt to get them by resorting to a strike, and they would be successful. It must be remembered that their unions were not mere ropes of sand, but strong unions, with power to make levies. We had seen what had been done in the cotton trade, and depend upon it when the engineers came to ask for it the eight-hour day would be fixed as a standard, if it had not previously been obtained by legal enactment. If workmen were treated by employers, managers, and foremen less as menials and more as fellow-men, more work would be got out of them, and there would be more satisfaction all round.

The discussion closed with a vote of thanks to Mr. Iorns for his paper.

The "Lewis" Link.

THE illustrations herewith represent a very simple method of connecting the top rod (which carries the points) with the copper tape of lightning conductors. It is claimed that this is the only coupling complete in one solid piece, this being a great desideratum, inasmuch as direct continuity is ensured. At the same time, the



danger of badly-fitting parts and careless adjustment is obviated, while less time is taken in fixing. The cost of the coupling is less than the ordinary forms. Mr. Joseph Lewis, Great Winchester-street, London, is the inventor and maker.

Principles, Possibilities, Curiosities and Limitations of the Crank Motion.—III.

THE slotted crosshead has the advantage, as a driving appliance, that by its use a motion of a reciprocating part of greater amplitude than the throw of the crank may be obtained, without the intervention of any intermediate mechanism; or any stroke, within reasonable practicable limits, may be made to drive a crank whose throw is of less amplitude than the stroke.

This is illustrated in Fig. 2, which exhibits a slotted crosshead, in which the slot is inclined at an angle to a perpendicular drawn to the line of direction of the stroke or the extended axis of the piston rod. This is an interesting and simple mechanical movement.

Peculiarities of this mechanical movement that I have not seen fully described elsewhere are, that while a crank of any radius may be made to work symmetrically with strokes of different lengths, the crankpin centre will at the end of the stroke not be in line with the centres of the piston and the crankshaft; and that the slide or friction roller working in the slot, instead of working during a semi-revolution from the centre of the slot to the extremity and then back to centre, will work from the point d down to c, and then back along the side $e\ d\ a$ to the point d' during the first semi-revolution of the crank; and during the second half-revolution will work upward from e to f' and then back along the curve $e'\ a\ d$ to the point d again.

This will be obvious from inspection of the figure, wherein the curved arrow indicates the direction of rotation, the straight arrow the direction of the stroke, and the parts are shown arranged as at the beginning of the stroke; and in which also C P is the line of centres of crankshaft and piston, while R d and R$'$ d' are the lines of dead centres of the crankshaft and crankpin. The crankpin is shown at the dead point, the position at f being the opposite dead point; and since the point g in the other line of dead centres must be brought to f by the semi-revolution of the crank, the line $g\ f$ measures the stroke. This length may be measured by a scale if the drawing be made accurately, and so determined graphically. Those who prefer may find it by using a table of sines and the following arithmetical rule:—

Rule.—Find from a table of natural sines and cosines, the sine of the included angle h in the centre of the figure. Divide twice the crank radius by the sine so obtained; the result will be the stroke.

Example.—The crank radius is 1ft., and the angle h is 30°. From a table of natural sines we find sine 30° is 0·5. Therefore, as twice the radius is 2′, we have $\frac{2'}{0\cdot5} = 4' =$ length of stroke.

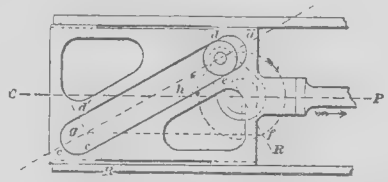


FIG. 2.

We see that the stroke which, with the slot at right angles with the line of stroke, would be just twice the radius, or 2′, is exactly doubled by inclining the slot to an angle of 30° with the line of the stroke.

The illustration presents a case where the slotted crosshead is driving a crank. This may be done with a slot at any inclination whatever.

The reverse, driving the crosshead by the crank, has a practical limitation very nearly reached in an inclination of 30°, at which and in greater inclinations the friction becomes excessive. However, an inclination of 30° will work fairly well.

It will be seen on inspection of the figure that the lines of dead centres, when the angle h is 30°, pass through points of the crankpin circle at 60° from the line of stroke extended through the crankshaft centre, and that this line also passes through the crankshaft centre and the centre of the crankpin. This may be generalised for all cases. The lines of dead centres in any straight-slotted crosshead, inclined or otherwise, will pass through a point in the crankpin circle at twice the number of degrees of arc from the stroke line produced as are contained in the angle of inclination of the slot to the stroke line; and this line always passes through the centres of the crankpin and crankshaft.

It follows that if we can construct a slot in some form other than straight, so that these two things cannot simultaneously occur, we shall have abolished dead points. Can this be done? We shall see in a subsequent article.

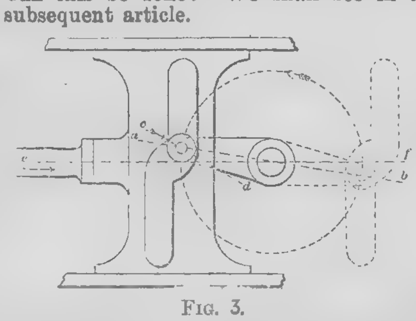


FIG. 3.

In 1866 I was interesting myself in the problem of devising a liquid meter, and made several on different plans. One of these required that a reciprocating part should produce a rotary motion of a spindle in one direction only. The motion required was very slow, the reciprocating movement being slow. The mechanism had to work under water. There were serious objections arising from peculiarities of construction against using a ratchet and pawl movement. Perhaps I may as well say that the rotary motion was required for operating valves, and that as the valves had to be moved in the manner of the slide valve back and forth, the ratchet and pawl movement was not competent to operate them as desired.

The problem was to produce the rotation first from a reciprocating part (a diaphragm analogous in action to the bellows of an ordinary dry gas meter), and then by this rotary movement to work the valves. The rotary motion was needed to be positive and always in the same direction, hence there must be no dead points.

After much thought, I invented the form of slotted crosshead shown in Figs. 3 and 4. I published a description of the movement, with a cut (the description very brief, and not going into details of laying out the slot given below), in a technical paper to which I was then a contributor—in 1867, I think.

Since that time I have seen the movement described in another technical journal, but either the originator of the movement (which I am sure I may claim to be) was unknown to the editor, or he did not care to name the inventor—it matters not which. I did not take the trouble to call his attention to the omission. I have sought in many books to find any account of this device prior to my application of it in 1867. It effected the motion required admirably, and at one time I thought I would apply for a patent upon it, but did not carry out this intention. I think it could be made useful not only for working valves, but for many other purposes, of which may be mentioned the actuation of revolution indicators. Indeed, I once made several registers for meters, in which such a slotted crosshead turned a crank that operated the recording mechanism. These registers operated very nicely.

Perhaps, before closing this little history, I might add that when I announced to an old and skilful Scotch mechanic (the day after I had to my satisfaction finished working out the device) that I could turn a crank always in one direction by a single reciprocating part and without a fly-wheel, he offered to bet me a new hat that I could not do it, whereupon I accepted the wager, pulled the model out of my pocket and won the hat. It was a fine silk hat, but it came to grief the first time I wore it in triumphant mood. "Pride goeth before destruction, and a haughty spirit before a fall," wrote Solomon the wise. Standing beside a rather low gas bracket over a workman's bench to clean out the bowl of a meerschaum, I was startled by roars of laughter from all parts of the shop, the old Scotch mechanic almost going into convulsions, and fairly

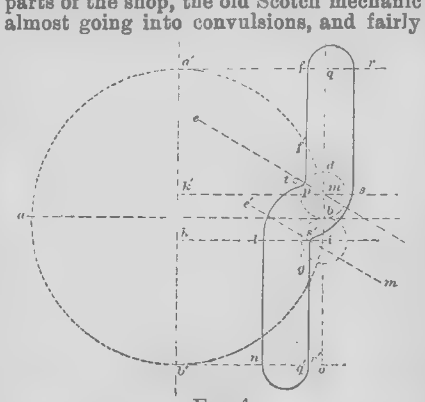


FIG. 4.

lying down on his bench and rolling with mirth at something of which I very soon discovered I was the object. In cleaning that pipe, I had held the hat too near the flame, and burnt the top entirely off.

So much by way of history. Now let us look briefly at the principles of the movement.

I have thought best to show the device in two positions—the beginning of the out-stroke and the beginning of the in-stroke or back-stroke of the piston that moves the crosshead. Fig. 3 illustrates the position of the crank and crosshead at the beginning of the out-stroke in full outline, the crank position with relation to the slot being shown in dotted outline for the beginning of the in-stroke. The arrows indicate the directions of the reciprocation and the rotation. The line $a\ b$ is the line of centres. The line $c\ d$, cutting the line of centres, forms an angle of 15 degrees with the line $a\ b$ in this instance; but it will be seen readily that this angle may be greater or less than 15 degrees if desired. The arrow drawn in the line $c\ d$ indicates the point to which the impelling force is applied. Now, the direction of the impelling force is neither in the line $a\ b$ nor $c\ d$, but in $e\ f$. At the beginning of the stroke, then, the impelling force does not act in the line of centres $a\ b$, hence at this period there cannot be a dead point.

The same state of things occurs at the beginning of the in-stroke. Now, as the point of application of the impelling force at the beginning of the out-stroke is above the line of centres of the crankpin and crankshaft, the crank must move downward; and it can be seen that the force will be thus applied till the crankpin reaches its lowest point. Thereafter, till the end of the semi-revolution, the application of the driving force will be below the line of centres. There is, therefore, no dead point in the first semi-revolution. Similarly it can be shown that there is no dead point either at the beginning or in any part of the return stroke.

I found at first that it was no joke to lay out the outline of the slot for any assumed angle of the crank with the line of stroke, and for any diameter of friction wheel.

To save anyone who may read this article, and who may desire to use the movement, the trouble of working out the graphic problem, I have shown in Fig. 4 the way to do it, which, with the accompanying explanation, will enable any draughtsman to do the work easily and rapidly. As 15 degrees angularity between the lines $a\ b$ and $c\ d$ (Fig. 3) are sufficient to ensure an easy passage of the centres, the illustration and explanation are based on that angle. With crank-radius (distance from centre of crankshaft to centre of crankpin) draw the crank circle, $a\ b'$, $b\ a'$ (Fig. 4), and draw the diameter $a\ b$ in the line of the stroke of the piston; also draw the diameter a', b', at right angles with $a\ b$.

With a radius equal to that of the friction wheel, lay off on each side of b the points m and i as centres, and with these centres draw circles, each representing the friction wheel.

Draw through the centre m the line d, m, i, o, parallel to $a'\ b'$. From the point d (intersection of the line g, m, i, o, with the friction wheel circle in the upper position) as a centre, and with the radius of the friction wheel, find the point e, 60 degrees from d, and draw $m\ e$, producing this line toward the vertical diameter a', b'.

Draw f, g tangent to the friction-wheel circles on the inside; and taking the point of intersection of $f\ g$ with $m\ e$ as a centre, draw a small fillet arc tangent to the friction-wheel circle in the upper position.

Draw $k\ i$ parallel to $a\ b$, and with i as centre draw the arc $e\ l$ tangent to the fillet.

Draw $b'\ o$ parallel to $a\ b$, and $l\ n$ parallel to $a'\ b'$. Draw also $a'\ o'$ parallel to $a\ b$ and $f\ p$ parallel to $a'\ b'$ and tangent to the small fillet arc.

With radius equal to that of the friction wheel, set off from f the point q on the line $a'\ r$, and with q as centre draw with the same radius the semi-circle $f\ r$.

With the same radius and n as centre set off on the line $b'\ o$ the point q', and with q' as centre draw the semi-circle $n\ o$.

Draw $k\ m$, extending the line through m. Draw $r\ s$ parallel to $f\ p$, and $r\ s$ parallel to $l\ n$.

Draw $e'\ m'$ parallel to $e\ m$, and with a centre taken on the line $e'\ m'$ draw a symmetrical fillet like that at p to ease off the angle formed by the junction $r'\ s'$ with $k\ i$. With radius equal to $i\ l$ and centre t (found from the point s and the fillet arc at s') draw the arc $s\ s'$. The outline $f\ p\ l\ u\ r'\ s'\ s\ r$ is now the outline of the slot.

It will be noticed that for a slotted crosshead of this kind a friction wheel *must* be used. Also it may be pointed out that the stroke is longer than twice the crank radius.

Again, there will be a little lost motion at the reversing of the motion of the crosshead at the beginning of each stroke, and if this movement were to be applied to a steam engine a very nice adjustment of compression would be required to avoid thumping. I have never tried the device on an engine, but I think it could be made to work smoothly, if designed especially for that purpose.

By the way, at present there exists no way of regulating compression in steam engines except by the design and adjustment of valves. If cylinder clearance could be made greater or less at will, and in the designing of valves exhaust closure were made to compress for maximum clearance, reduction of clearance could be made to compress to any extent above initial pressure within such a limit of pressure as would lift the valve from its seat. I throw this out as a hint at one of the possibilities of the crank not yet worked out. A compression to take up momentum of reciprocating parts that could be increased or diminished, while the engine is running, with the same facility as a throttle can be closed or opened, is, perhaps, worth thinking about.

Further, in the slotted crosshead of the kind shown in Figs. 3 and 4, the crank cannot move continuously except in one direction. It could not be used for a reversible engine.

Lastly, before leaving the discussion of slotted crossheads, it may be said that the form shown in Fig. 3, as well as any other form of slotted crosshead, may be used with a rock-lever, or rather such slots may be used in rock-levers for driving cranks, and it was thus that I applied it to meter registers, as above stated.

(*To be continued.*)

Two omnibuses at Sheffield have been lighted by electric light. The lamps are 6C.P., the current being obtained from a storage battery, weighing 8lb., placed under the seat.

Shipbuilding Notes.

Messrs. Bishop, Miles and Co., Bristol, launched, on the 18th inst., a steel screw steamer for passenger service on the river Avon.

The Fairfield Shipbuilding Company have received an order from the Castle Line of South African mail steamers for the construction of a new steamer similar in character and tonnage to their "Dunottar Castle."

Messrs. Kincaid and Co., engineers, Greenock, have contracted to build a small paddle steamer (the hull of which will be constructed by Messrs. John Reid and Co., Whiteinch) for the Goole and Humber trade.

Messrs. W. B. Thompson and Co. Limited, Dundee, have secured an order for a steel screw steamer for the Edinburgh and London Shipping Company. The new vessel will be fitted with powerful triple-expansion engines, and all the latest improvements for passengers and cargo.

The steamer "Nile," which has been built by Messrs. J. and G. Thomson, of Clydebank, for the Royal Mail Steam Packet Company, was launched on the 21st inst. The dimensions are:—Length between perpendiculars, 420ft.; breadth, 52ft.; depth, moulded, 35ft. 5in.; tonnage, about 6000 gross.

On the 21st inst., Messrs. Craig, Taylor and Co. launched from their Thornaby shipbuilding yard, Thornaby-on-Tees, a steel screw steamer of the following dimensions:—244ft. by 34ft. by 17·9ft. depth, moulded. Her engines have been supplied by the North-Eastern Marine Engineering Company, Sunderland, and have cylinders 18½in., 30in., and 49in. diameter, by 33in. stroke.

On the 21st inst. the largest steamer for purely cargo purposes yet built on the Clyde was launched from the shipbuilding and engineering works of Messrs. Alex. Stephen and Sons, Linthouse. She is a schooner-rigged steel screw steamer of about 5000 tons gross register. Her dimensions are:—Length, 400ft.; breadth, 48ft.; depth, moulded, 31½ft. The engines, constructed by the builders, are of the triple-expansion type, having cylinders 26in., 41in., and 67in. diameter by 48in. stroke. The boilers are of the double-ended type, and are designed for a working pressure of 160lb. per square inch.

Messrs. Laird Brothers launched, on the 22nd inst., from the Birkenhead Ironworks, a screw despatch vessel for the Government of India. She is built of steel, and is of the awning-deck type, with clipper stem and elliptic stern, rigged with two masts as a fore-and-aft schooner. She has a length of 205ft. 6in.; beam, 31ft. 6in.; depth to awning-deck, 22ft. 9in.; and a gross tonnage of about 930 tons. The builders will supply a set of direct-acting inverted engines of the triple-compound type, having cylinders 22in., 34in., and 51in. diameter, with a stroke of 2ft. 9in. The two steel boilers are cylindrical double-ended, about 12·3ft. diameter, 14·10ft. long, and are fitted with corrugated furnaces and iron tubes, and have a total heating surface of about 5070sq. ft., being stayed for a working pressure of 160lb.

The Institution of Naval Architects.

The annual meeting of this Institution was held on Wednesday, Thursday and Friday of last week, in the hall of the Society of Arts, London, the Earl of Ravensworth (president) occupying the chair. On Wednesday, after the presentation of the report of the Council, the Right Hon. Lord Brassey, K.C.B., was elected president in place of the Earl of Ravensworth, who resigned at the close of the meetings. Other formal matters having been proceeded with, Lord Ravensworth delivered his inaugural address, to which reference is made in another column, after which the reading of the papers was commenced.

CRUISERS IN NAVAL WARFARE.

The first paper read was by Rear-Admiral S. Long, "On the Present Position of Cruisers in Naval Warfare." In view of the approaching completion of the Hamilton programme, comprising no less than 41 vessels classified as cruisers, it occurred to the author that it might prove advantageous to contribute some remarks on the work which such vessels would be likely to be called upon to perform in case of war, and hence the present paper. He pointed out that the work of cruisers in war was comprised under three heads:—(1) To act as look-out ships or scouts for fleets; (2) to act independently of fleets for the protection or attack of commerce, as well as for distant expeditions; (3) to convoy slow steam traders. Having dealt at some length with these points, the author summarised his impressions as follows:—(1.) That speed and coal endurance were qualities of primary importance in cruisers, and should be associated with high freeboard; but that the fighting qualities should never be diminished below those of corresponding vessels of other nations, but, if necessary, resort should be had to increased displacement. (2.) If a quantitative estimate may be hazarded, the minimum sea speed now acceptable should be 20 knots, and the coal supply sufficient to last a minimum of seven days, 20 hours each day at 10 knots, and four hours at chasing speed, besides enough to proceed to and from the base at 10 knots and fight an action. (3.) That powerful cruisers at the end of a telegraph wire would be more conducive to sea power than numerous small ones, where ocean routes were concerned. (4.) That subsidies should be given to steamship companies for all vessels maintaining a sea speed of 21 knots. (5.) That the convoy of slow merchant steamers was likely to form an important feature of naval work in war, and would be a more effectual and economical means of protecting trade, by ensuring the simultaneous presence of warship and merchantman, than any other at present contemplated.

MERCHANT CRUISERS.

A paper by the Right Hon. Lord Brassey, K.C.B., was then presented on "Merchant Cruisers: Considered with Reference to the Policy of Maintaining a Reserve of Vessels by Annual Subventions to Shipowners." The author considered that no more important question could be brought before the Institution than the policy to be pursued by the British Government in regard to mail subsidies and subventions to the owners of the reserved merchant cruisers. The tonnage owned by Great Britain included 9506 sailing vessels, collectively measuring 3,602,546 tons, and 5588 steamers of 8,912,522 tons. The United States, which ranked next to us in sailing tonnage, owned 3428 vessels, aggregating 1,116,963 tons; whilst Germany, which stood next in steam tonnage, owned 765 ships, aggregating 1,091,472 tons. It might broadly be said that to England belonged half the mercantile tonnage of the world. When, however, a comparison was made of those classes of ships on which we should be chiefly dependent in the event of war, and which in time of peace carried mails and passengers, our relative position was not so commanding as might be wished. The latest returns of the Bureau Veritas showed that the merchant navies of the world possessed 45 steamers exceeding 6000 tons. Of these 10 were French, 1 Belgian, 7 German, and 27 English. Of the 10 largest steamships of the world, 7 were British; of the 14 ocean steamers of 19 knots speed and above engaged in the Atlantic trade, 6 were British, 5 German, 2 belonged to the United States, and 1 to France. Thus it would be seen, remarked Lord Brassey, that in the largest and swiftest ships we held no uncontested supremacy. Supported by lavish subsidies, mail steamers sailing under other flags were running a closer race every year with the British lines of ocean steamers. Great Britain, with a total foreign trade of £740,000,000, only paid subsidies for mail services to the extent of £665,000; whereas France, with a trade of £300,000,000, paid £1,043,513, and Germany, with a turnover of £313,000,000, paid £1,000,000 as subsidies. The amount given by Great Britain was too nearly covered by the receipts in foreign and colonial letters. The author then detailed the subsidies paid to different British and foreign shipowners by their respective Governments, and said that the competition created by the aid of subsidies constituted a serious difficulty for British shipowners. Although some had been disposed to question the policy of subsidising mercantile auxiliaries and giving subventions to mail steamers, he expressed the opinion that without the help of the State it would be impossible to compete with the highly-subsidised mail steamers carrying foreign flags. He concluded by stating that nothing could better conduce to the closer union of the Mother Country and her colonies, especially her Australasian colonies, than the improvement of the means of communication. Already the feat had been performed by the "Ophir," of the Orient Line, of delivering the Australian mails in London in 24 days from King George's Sound. The distance from New Zealand by Cape Horn had been covered by the "Arawa" in less than 35 days. If so much could be done by unaided enterprise, it was evident that, with the help of the Government, granted upon conditions which would ensure the building of vessels representing the finest work of our mechanics and shipbuilders, a yet further closing up of the intervals separating the Mother Country from her daughter States would be assured. It was difficult to measure the benefits which would result, alike to the commercial, political, and social relations of the British Empire.

THE STRENGTH OF BULKHEADS.

On Thursday a paper by Dr. F. Elgar, LL.D. (vice-president), was presented, entitled "Some Considerations Relating to the Strength of Bulkheads." At the outset the author mentioned that the report of the Board of Trade Committee upon the spacing and construction of watertight bulkheads in ships raised the question of how the strength of a large area of perfectly flat, thin steel plating, which was supported at the edges and subjected to normal pressure, might be determined by calculation. That was the simplest form of the question thus raised. In applying it to the case of a ship's bulkhead they required to deal not with a continuous area of plating whose thickness was uniform, but with an area made up of separate plates that varied in thickness and were connected with riveted joints; and which had stiffening bars riveted across in parallel lines at equal distances apart. The Appendix B to the report of that Committee, after giving rules for the construction of bulkheads, which fixed the thicknesses of plating, the sizes and arrangements of stiffening bars, etc., concluded by stating that "any other method of construction of equivalent strength may be allowed, provided the plans and, if necessary, the calculations, be approved by the Board of Trade." The Appendix C, which was preferred by two members of the Committee, differed somewhat from that upon points of detail, but concluded with a similar proviso. Mr. Martell, in a paper read before the Institution last session, had commented upon that portion of the Bulkhead Committee's report, and in the discussion which followed, Dr. Elgar expressed the opinion that in the present state of our knowledge of how to deal accurately with the subject, no calculations that were made of the stresses set up in large plane areas of plating, when supported all round the edges and subjected to normal pressure, had any exact value. The author suggested that a series of test experiments upon the resistance to flexure of thin flat plates under those conditions were absolutely essential before any method of calculation could be accepted as trustworthy. Having been prevented from fulfilling his intention of making such tests, he presented the paper by way of explanation of his remarks last session. He came to the conclusion that it was impossible in our present knowledge of the subject to determine the strength of bulkheads by mathematical calculations, and that much was required, both in the way of mathematical investigation and of quantitative experiment upon the flexure of thin plates under normal pressure, before any such calculation that might be attempted could be considered sufficiently exact to serve as a guide in practice.

WAKE CURRENTS.

A paper was next read, "On the Measurement of Wake Currents," by Mr. G. A. Calvert. The author described some experiments on a comparatively small scale, which he had made during recent years, with a view to ascertain the actual condition of the water around the stern of a moving vessel.

PROBLEMS OF SHIP PROPULSION.

"The New Afonasieff's Formulæ for Solving Approximately Various Problems connected with the Propulsion of Ships" was the title of a lengthy mathematical paper by Capt. E. E. Goulaeff. It dealt with the researches of Fleet-Engineer Afonasieff, of the Russian Navy, who proposed ready formulæ by which many problems in connection with the propulsion of ships might be solved with a sufficient degree of accuracy for all practical purposes.

THE TRANSMISSION OF HEAT THROUGH TUBE PLATES.

"Some Experiments on the Transmission of Heat through Tube Plates" was the title of a paper read by Mr. A. J. Durston, Engineer-in-Chief of the Navy. This dealt with tests carried out at Devonport during the past three years with a view to ascertain the temperature of tube plates and tubes under certain conditions of working, and their bearing on the leakage of tubes. The experiments were at first conducted on a small scale. One was to determine the temperature of a tube plate at which injurious overheating (*i.e.*, such as to cause leaky tubes) took place. A small boiler having 24 tubes, 2½in. diameter, was used, the tube plate being ⅝in. thick. Of these tubes eight were brass, seven steel, and nine iron. A calculated amount of water was put into the boiler, such that when wholly evaporated the internal pressure would be 100lb., means being taken to prevent a rise of pressure. The boiler was placed over a forge with the tubes vertical and the blast put on and continued until the tube plate showed a red heat, equal to 1400° F. The pressure fell as the plate overheated. After being allowed to cool, and on testing with water, all the tubes leaked so badly that no pressure could be obtained, but no difference was noticed in the behaviour of the brass, steel, or iron tubes. This indicated that raising a tube plate to red heat caused tubes of all those materials to leak badly. The plate was then drilled with holes, and plugs, first of lead and secondly of zinc, were inserted. The previous test was repeated in each case, and the results led the author to assume that a tube plate to be overheated sufficiently to make the tube joints leak to any appreciable extent must be raised to the temperature of melting zinc—viz., 750° F. These experiments were repeated on an extended scale in 1892. There was used an experimental boiler, with its built-up brick furnace working with closed ashpits and moderate air pressure. Five of the tube holes had each four pieces of fusible alloy, ⅝in. long, let into the plate at the middle of its thickness. The mean steam pressure was 143lb. and the maximum 150lb.; the maximum temperature in the combustion chamber was 3100° F., and the maximum temperature of the steam 366° F. At the conclusion of the trial it was found that of the pieces of fusible alloys placed in the tube plate, all the six whose melting points ran from 435° up to 490° F. had fused completely. The ten ranging from 540° upwards remained unchanged. Of the intermediate ones, those having melting points of 500° and 510° remained unchanged, whilst two others with melting points of 520° and 530° were fused just at the ends near the tubes. It would appear, therefore, that the temperature of the plate at the middle of its thickness did not rise to 540° F., but at some of the tube joints it rose to 530° F. Further tests were then made with this boiler enclosed in an air-tight stokehold and with forced draught. In addition to the fusible alloys let into the middle of the plate, four pieces or pellets, $\frac{3}{16}$in. length and $\frac{3}{16}$in. diameter, were fitted into the face of the plate. Four tests were then made; three were of five hours' duration. In the third trial 9lb. of oil was admitted to the boiler mixed with the feed; on the fourth trial an additional 5lb. of oil was added, and the tubes gave out, after 3⅝ hours' run. The pellets in the tube plate (around three tubes in the hottest part of the plate) melted in the case of all the zinc and alloys; the antimony melted in two other instances, but remained intact in one, whilst in two other cases the antimony and zinc remained intact. This showed that the plate was about the temperature of 1060° F., at all events during the latter part of the trial; whereas from the results of the third trial the tubes remained quite tight up to and above the temperature of melting zinc—750° F. Experiments were then made as to the behaviour of Lowmoor iron *versus* steel tubes as regarded leakage in the experimental boiler. The results appeared to show, observed the author, that the former were at least not superior to steel tubes, and as they knew from experience that the latter would stand more rolling than the ordinary iron tube of commerce, that justified their preference for steel tubes. As far as the introduction of grease was concerned, the experiments showed that grease had a very deleterious effect upon the tubes, causing them to leak. Passing on to the consideration of experiments made on a larger scale on shipboard, the author mentioned the well-known fact that the Admiralty had experienced considerable trouble with leakages of tubes in the double-ended common combustion-chamber boilers, and those of the locomotive type. Of the former there were three kinds, distinguished by having two, three or four furnaces at each end. With regard to the two-furnace type, various expedients have been tried in ships so fitted to overcome the leakage; but no beneficial results had attended any of the measures until the removal of two vertical rows of tubes over the centre of each furnace. This modification had been applied to all boilers of that type, and also to those having three or four furnaces at each end; but the results in these cases were not so satisfactory.

Concurrently with the efforts that were being made to overcome the leaky tube troubles by improving the circulation, experimental trials were being conducted in the locomotive boilers of the torpedo-gunboat class: (1) By plastering the tube plate with a non-conducting composition, thus protecting it on the fire side; and (2) by ferruling the tubes with fireclay cap ferrules, the caps of which afforded protection to the tube ends and the larger part of the tube plate. The object of these experiments was to show whether the leakages of boiler tubes were not due to the overheating of the tube plate and ends. This was established, for as long as, in the

first case, the cement adhered, and in the second case the ferrules lasted, leakages did not occur. They were, however, both liable to rapid destruction, and could not be relied on as a permanent protection. Amongst the first of the practical suggestions made for ferruling the tube ends was that patented by Messrs. Humphrys, Tennant and Co. This ferrule was screwed into the tube at the firebox end, and the cap fitted into an annular recess cut in the tube plate. The principle was that when a contraction in diameter took place, due to variations of temperature, the outer part of the ferrule tended to tighten upon the concentric portion of the tube plate. sThese ferrules were fitted in the two after ix-furnace common combustion-chamber boilers of the "Medea." An eight hours' trial with natural draught showed that about 70 tubes in all had leaked very slightly, and that the ferrules had practically not scaled by oxidation. The leaks were so trivial that nothing was done to them before proceeding with the four hours' forced-draught trials. On examination, slight, unimportant leakage of the tubes was observed, and the ferrules were practically free from oxide scale. Shortly after that ferrule was suggested, Mr. Peck, of Messrs. Yarrow, proposed another. In this, the tube ferrule or protector did not touch the tube where it was fixed to the tube plate, but was in contact with the tube only at a part where all its heat might be readily absorbed. It would be observed that Mr. Peck considered the space produced by the rolling of the tube in the tube plate would be effective in producing the desired result. The idea of a space formed between the ferrule and the tube at its junction with the firebox tube plate was recognised as an important point, and shortly afterwards Mr. Oram proposed to the author a cap ferrule which provided an effective air space between the ferrule and the tube at, and for a short distance beyond, its junction with the tube plate, and by its cap also protected the greater portion of the firebox tube plate from direct contact with the products of combustion, and proportionally reduced the formation of steam on the water side of the tube plate. Exhaustive trials were made with these cap ferrules, and with both natural and forced draught, with the result that not a single tube leaked. These cap ferrules had been introduced on various vessels with great success, and requests for them were being made by ships of the Fleet with a view to protect the tube plates and ends from overheating, produced by accumulation of grease or scale in the boilers. It was submitted that these cap ferrules had fully answered their intended purpose.

(To be continued.)

Comparative Experiments on the Strength of Metallic Chains.*

BY PROFESSOR HARTIG.

THE following table contains the leading results of tests of chains of various kinds,

—	Weight per Foot.	Equivalent Elastic Length.	Equivalent Breaking Length.	Elongation at Elastic Limit.	Elongation at Fracture. Total.	Elongation at Fracture. Elastic.	Specific Work of Rupture for Unit Weight (1lb.).	Ratio of Tensile Strength of Chain to that of Bar of Raw Material, of equal minimum cross-section	Ratio of Total Elongation	Ratio of Specific Work of Rupture
	Lb.	Feet.	Feet.	Per cent.	Per cent.	Per cent.	Ft.-Lb.			
1. Clock chain, steel wire	0·041	1,145	2,027·50	1·48	48·50	2·62	875·760	0·0726	5·16	·858
2. Loom chain, " "	0·222	..	1,430·83	..	13·25	..	793·760	0·0861	5·15	·401
3. " " iron "	0·8079	537·5	938·33	..	52·20	..	469·040	0·0485	3·06	·165
4. "Vaucanson" chain, steel wire . . .	0·405	777·5	1,840·83	1·12	34·00	2·74	547·76	0·110	2·57	·276
5. "Ewart's" driving chain, malleable cast iron . . .	1·572	..	2,335·83	..	9·94	2·10	367·36	0·138	1·00	·753
6. Ordinary chain . .	8·790	1,630·83	6,391·66	0·2	20·00	8·80	895·44	0·397	0·715	·220
7. "Gladstone's" chain, brass wire . . .	0·227	..	9,450·00	..	19·64	..	1,111·92	0·633	0·569	·267
8. "Gladstone's" patent chain, brass sheet.	0·071	..	7,183·33	..	32·80	0·37	1,590·80	0·719	1·49	·895
9. "David's" patent chain, mild steel .	10·872	2,880·83	8,925·00	3·27	12·50	10·13	859·36	..	..	..
10. "Oury's" steel chain, made out of a single rolled bar . . .	9·542	..	10,791·66	..	14·10	..	..	..	..	..
11. Pitch chain, wrought iron	5·825	..	1,664·16	..	0·69	0·28	6·626	..	..	..

carried out partly under the supervision of the author, and partly by others.

The equivalent elastic length (*Traglänge*) is the length which would be necessary to strain the chain to the elastic limit by its own weight.

Similarly the equivalent breaking length (*Reisslänge*) is the length which would be required to rupture the chain by its own weight.

These quantities, together with the "specific work of rupture," are frequently employed in Germany as a criterion of the character of a test-piece.

The original contains a supplementary table, compiled by the author on the assumption that the elastic limit of each chain has been raised by repeated tests to two-thirds of the breaking strength, as is usual in the case of heavy chains.

The tabulated results are selected by the author from the more numerous examples recorded in the text of the original.

* Inst. C.E.: Foreign Abstracts.

Telescopic Hydraulic Lift at Marseilles Docks.†

THIS lift was erected in November, 1891, in the staircase-well of the Dock Company's offices (Hôtel de la Direction des Docks). It was designed by Mr. Samain, of Paris, on his patent telescopic system. The telescopic principle was adopted for the lift-rams, because the nature of the ground below the building made it impossible to employ a cylinder of the length necessary for an ordinary direct-acting lift. The weight of the lift-rams and cage is approximately neutralised by a vertical hydraulic balance, the pressure on the piston of which is produced by weights.

To the upper side of the balance-piston is connected a concentric cylinder of smaller diameter, sliding over a fixed piston. From the action of the water from the high-pressure mains—used to supply the hydraulic machinery in the docks—on the lower end of this cylinder the motive power for raising the lift is derived. The total pressure need only be that necessary to overcome the unbalanced load and the friction. As the cage ascends the column of water under the telescopic rams rises, and an increasing load has to be balanced. In order to adjust the pressure on the balance-piston to the varying load, a device has been adopted which constitutes the special feature of the machine. The balance-weights are connected by radius bars or links to the exterior of the motive-power cylinder—which also forms a piston-rod to the balance piston,—and the vertical motion of the weights is retarded or accelerated, relatively to that of the piston, by means of fixed curved guides on either side of the balance-cylinder, which act like cams. Thus the pressure exerted by the weights on the piston varies according to the extent to which they are horizontally deflected by the guides.

The hydraulic balance-cylinder has a diameter of 16·14in., and a length of 8ft. 10·3in. The diameter of the motive-power cylinder is 4·91in. Above the balance-piston, on the area not occupied by the motive-power cylinder, atmospheric pressure is maintained. The exhaust pressure from the motive-power cylinder is, however, about 2 atmospheres, as the water is returned to the tanks at a certain elevation. The pressure of the water from the mains is about 739lb. per square inch, while that in the balance-cylinder does not exceed about 90lb. per square inch. The total lift is 68ft. 10·78in.

There are four telescopic rams, all working within each other, and into a fixed cylinder of 6·06in. diameter, sunk in the ground. The smallest ram has a diameter of 4·4in.

In order to avoid shocks during the ascent, at the moment when each ram reaches the end of its stroke, the water enclosed in the annular clearance space between the ram in question and that in which it slides is throttled at the proper moment, instead of being allowed to pass freely from the annular space to the interior of the ascending ram. An arrangement is provided to compensate automatically for the leakage thus caused. During the descent shocks are prevented by means of a kind of dash-pot, which comes into operation as each ram approaches the lower end of its stroke. These devices have not proved quite successful in practice, as—without being at all dangerous—shocks are still perceptible.

In addition to the usual guides for the cage, the second of the telescopic rams carries a crosshead by which the telescopic column is also guided about the middle of its height. This has, however, been found superfluous, as the column tends naturally to maintain itself in a perpendicular position, provided the lower end of the hydraulic lift-cylinder is not rigidly fixed.

The distribution of water to the lift is controlled by a piston-valve actuated in the usual way. The cage can be automatically stopped at any floor by means of projecting pieces acting on the valve-rod. As a rule the whole lift—of 68ft. 10·78in.,—with three persons in the cage, is effected in rather less than two minutes; the descent is somewhat more rapid. The quantity of water used for one complete lift is about 1·059 cub. ft.

The author discusses the question of safety, and arrives at the conclusion that a practically impossible combination of breakages in different parts of the machine would be required to produce a serious accident.

† Inst. C.E.: Foreign Abstracts.

Engineering Students' Club, Newcastle-on-Tyne.

A MEETING of the above club was held in the Durham College of Science, on Wednesday, the 22nd inst., when Mr. A. Clement Hovey read a paper on "Practical Work in the Construction of Boilers for Land Use." Edward Towers, Esq., occupied the chair, and there was a large attendance of members.

The author discussed the most suitable qualities of materials for the various positions in boilers, and exhibited test specimens of the same. The different methods of procedure in the bending, flanging, welding, drilling, riveting, etc., of the plates, and their cost, were commented upon. The best of these, and the requisite machinery by first-class makers, and also the arrangements of shops for different classes of boiler work, were fully explained, and were illustrated by lantern views and drawings. The lecturer concluded with a description of the details of ordinary and patent boilers for land use, with the necessary and most improved mountings.

A hearty vote of thanks to Mr. Hovey for his interesting and instructive paper terminated the proceedings.

Catalogues, Price Lists, Etc.

Engineers, Tool Makers, Metal Merchants and others are invited to forward Catalogues, Pamphlets, Circulars, Price Lists, etc., for notice in this column.

FROM Mr. R. AYLMER, 47, Victoria-street, London, we have received a copy of the second edition of an illustrated catalogue of Leclanché and Leclanché-Barbier batteries. Illustrations and particulars are given of all the well-known forms of Leclanché battery and also of the Leclanché-Barbier cylindrical agglomerate batteries of both wet and dry types. These latter are now being introduced into this country for the first time, although they have for some time been favourably known abroad as a very efficient and economical cell. Particulars are also given of the new Aylmer-Leclanché low-resistance batteries and Leclanché telephones. The catalogue contains full instructions for using the cells to the best advantage, as well as prices of the various parts, etc.

From Messrs. P. R. JACKSON AND CO. LIMITED, of Salford, we have received a copy of a new edition of their price list of gearing, of which, as is well known, they make a speciality. The list contains illustrations and particulars of fly spur wheels, pinions, rope and belt pulley castings, worm and change-wheel castings, Ramsbottom piston rings, etc. We note that Messrs. Jackson now mould straight racks in ordinary lengths by machine, without full patterns. Any pitch or breadth of rack may therefore be fixed upon without reference to existing patterns or the cost of making new full patterns. This will also be a convenience in case of repairs where the original full patterns are not readily available.

Mr. THOMAS H. WHITE, Cross-lane, Salford, has sent us a copy of his new list of patent automatic restarting and exhaust steam injectors. We understand that both these injectors are now being adopted on the London and North-Western Railway Company's locomotives. Several illustrations are given of various types of injectors, with prices, duty, size of connections, etc., appended. Particulars are also given of White's renewable steam jet pumps, ejectors and water raisers, high-pressure jet pumps, and various fittings pertaining to these apparatus. Some general instructions on attaching injectors, etc., are also contained in this useful little catalogue.

From Mr. W. GUNTHER, Central Engineering Works, Oldham, we have received a copy of the fourth edition of his illustrated catalogue of turbines. Illustrations and particulars are given of the well-known Girard turbine, adapted for various falls and with horizontal shafts. Also of Jonval turbines, and improved Pelton wheel turbines. Much interesting data are included on water-power, etc., in this very useful catalogue.

Trade Notes.

Messrs. Ganz and Co., electrical engineers, Budapest, have declared a dividend of 20 per cent.

The Glengarnock Iron and Steel Company have booked a large order for steel fishplates for the Caledonian Railway Company.

The Krupp Works at Essen have obtained an order for 2550 tons of steel rails for the Herzogenrath Erndhoven Railway in Holland.

Messrs. Alexander Findlay and Co., Motherwell, have secured the steel contract in connection with the extension of Perth Station.

The Lincoln Wagon and Engine Company Limited have declared a dividend of 6 per cent., including the interim dividend paid in August last.

Messrs. George Glover and Co., Chelsea, have obtained an order from the Leeds Corporation for the supply of dry meters during the next twelve months.

Messrs. R. Laidlaw and Co., Glasgow, have obtained an order for the supply of 3100yds. of 9in. cast-iron pipes for the Tunbridge Wells Town Council.

Messrs. Hanna, Donald and Wilson, engineers, Paisley, have obtained the order for the valves for the new mains now being laid from Craigmaddie to Glasgow.

We are informed by Messrs. T. A. Crompton and Co., marine engineers, that they have removed to more convenient offices at 86, Leadenhall-street, London, E.C.

The contract for the supply of electrical plant and mains to the Kingston-on-Thames Town Council for their central station has been awarded to Messrs. Siemens Brothers and Co., of London.

The tender of Messrs. Alexander Brown and Sons, engineers, Londonderry, has been accepted for the supply of boilers, economisers, engines, etc., required for the electric lighting scheme at that town.

Messrs. Dorman, Long and Co., of Middlesbrough, have opened a yard at Nine Elms-lane, Vauxhall, London, in order to keep a stock of all the girders they roll, and several other sections of steel.

Mr. William Fieldhouse has acquired the general ironfoundry business hitherto carried on at Falcon Ironworks, Bradford, Manchester, by Mr. C. A. Haworth, and will carry on business under the name of Messrs. William Fieldhouse and Co.

Having regard to the enormous circulation of THE MECHANICAL WORLD, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if MECHANICAL WORLD readers will kindly bear this in mind as occasion arises.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 85, Strand, London, or New Bridge-street, Manchester.

The Design and Construction of Stationary Engines.—L.

FIGS. 213 and 214 show two additional forms of three-part bearings, having single adjusting screws, and represent Continental practice.

Fig. 215 shows a three-part bearing as made by a Lancashire maker. The adjustment is effected by means of wedges placed behind both side brasses, which are forced downwards by set screws passing through the cover. This arrangement of the wedges is open to the objection that there is no provision made to prevent the wedges working their way too far down, either by their own weight or by vibration, and pressing the brasses too hard on to the shaft. It is always desirable to be able to move the wedge blocks readily up or down, as desired, for which purpose it is usual to provide two setting-down screws, and a lifting bolt in the centre; otherwise this pedestal is of a good design and very substantial.

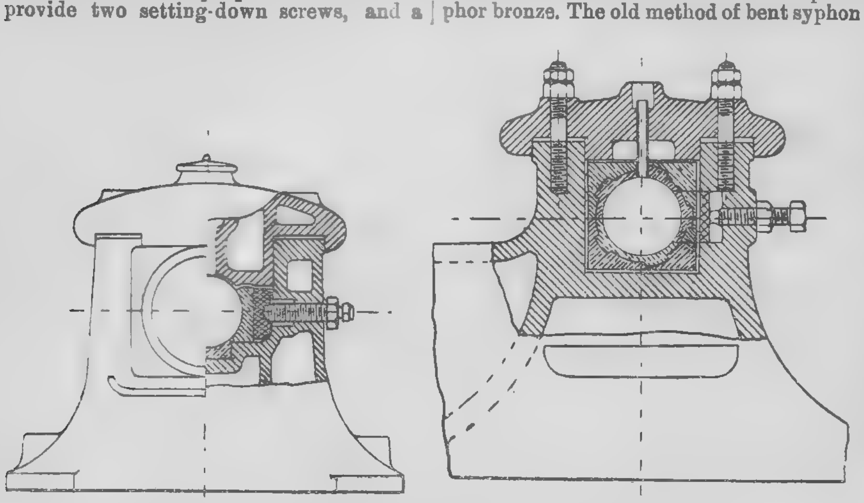


FIG. 213.—DESIGN, ETC., OF STATIONARY ENGINES.—FIG. 214.

Fig. 216 shows a form of bearing used in the Corliss engines of a well-known maker. The pedestal is formed in the front end of the engine framing, and is fitted with three-part brasses. The front brass has a taper wedge placed behind it, fitted in so that its lower edges bottom on the framing, and when wear is required to be taken up a portion is taken off the bottom of the wedge, allowing it to come lower down behind the bearing, and so take up the lost space. The inner or left-hand brass has a parallel packing piece placed behind it, which can have thin liners placed behind, should these be required to take up wear on that side. In this pedestal there is no top bearing provided, and the cap is simply a skeleton cover to protect the bearing from dust, etc. This type of pedestal is much used for large mill engines where the fly-wheels, being mostly rope drums, are very heavy, and as there is no tendency for the shaft to lift, no top brass is required, and the arrangement offers special facilities for thorough lubrication. Sometimes in these pedestals the caps are formed with projecting pieces inside, which fit on to the top edge of the side brasses, and so prevent any possible disturbance of these or tendency to work out of place.

(*To be continued.*)

The Under-type Stationary Engine.—XXVI.

WE should always insist on the use of two sets of water-gauge fittings, one set right-hand and one set left-hand. Boiler cocks can then be dispensed with. The adoption of two sets of water gauges secures a symmetrical arrangement of the front fittings, but it ensures absolute safety, which is a far more important matter. The gauge fittings are of the asbestos-packed type, which obviates all metallic contact in the working parts, and consequent cutting and scoring of the plugs, which can be opened and closed with ease.

Messrs. Hopkinson's patent Equilibrium water gauge, which was fully illustrated in THE MECHANICAL WORLD, October 30, 1891, may be highly recommended. This water gauge instantly closes the water passage when the glass breaks, and is therefore a protection to stokers. It ensures a correct indication of the water level in the boiler, for any gauge in which a false water level can be trapped is unreliable and dangerous. The lower or water arm of a water gauge, when at work, is subjected to a greater pressure than the top or steam arm, due to the weight of the column in the boiler. When blowing through the passages, the automatic valve in the lower or water arm is apt to be forced to its seat and held thereto by the aforesaid column pressure acting on the under side of the valve, thus closing the connection between the boiler and the glass, and thereby giving a false indication. To obviate the danger of trapping a false water level, Messrs. Hopkinson and Co. have patented the water gauge referred to, which only allows the automatic valve to be forced to its seat and held thereto when the glass is actually broken, the ball being sufficiently heavy to overbalance the pressure due to the column of water. Therefore the thoroughfare between the glass and the boiler will always remain open so long as the glass is intact.

The pressure gauge and syphon are shown by Figs. 56 and 57. The gauge is the Bourdon type; the case is made of brass, and the bent tube is of steel or phosphor bronze. The old method of bent syphon is not often used, the straight-pendant syphon being neater and preferable.

The steam-blast cock should, like all the rest of the cocks, be asbestos-packed, and should receive its steam from the base of the stop valve or safety valve, whichever happens to be fixed at the smoke-box end of the boiler, in order to avoid a separate hole being drilled for this.

The bearers for the firebars in all cases should be bolted to the ashpan, so as to avoid the screwing of studs into the water space of the boiler for carrying these. The arrangement of the bearer brackets is a simple matter for either wrought-iron or cast-iron ashpans. In fact, all through these articles we have tried to show methods of

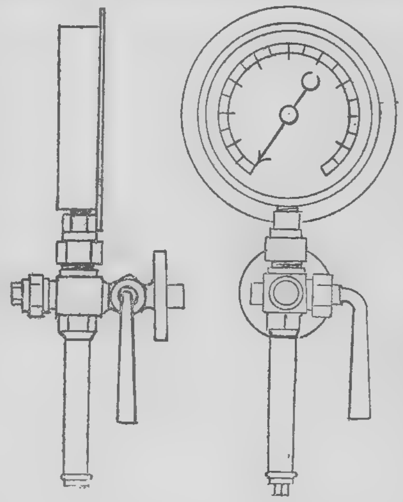


FIG 56. FIG. 57.

construction which will prevent the boiler being riddled with a ceaseless number of holes for carrying all manner of fittings. There are some bulky details that we have in mind, that are often bolted to the water space of the firebox, that would be just as convenient if bolted to the smokebox or the ashpan, and thus do away with a number of studs likely to leak, and have dry joints, which are far preferable.

In most cases our acknowledgments have been tendered to the many firms who have lent blocks and placed information at our disposal. We, however, omitted to mention Messrs. Ransomes, Sims and Jefferies' name in connection with the description of the winding drum in Article XIV.

Want of space has prevented the insertion of any illustrations of firedoors, firebrick bridges, lined chimney bases and downtakes with dampers, smokebox door fasteners, spark catchers, and other details connected with this part of the subject.

W. F.

(CONCLUDED.)

The Mannesmann Process of Seamless Tube Rolling.

(*Continued from page 104.*)

THE Mannesmann process, the subject of this paper I have the honour of bringing before you this evening, is a process undoubtedly the outcome of all the tube-making processes. The Mannesmann process possesses properties hitherto not contemplated, and will, I have no doubt, at no distant date revolutionise the tube industry.

A little over 22 years ago—viz., on the 31st October, 1870—a patent was granted to George Walter Dyson and Henry Arthur Hall, for improvements in rolling finished circular metal, plain or irregular rods or tubes, which, as regards rods, has had considerable application in Sheffield, especially at the Corbrook Forge, where the invention was first brought out.

The open-hearth or Siemens steel above all possesses the advantage of being cheap, of having the right amount of toughness and other qualities which fit it for the special purpose of rolling solid ingots direct into tubes by rolling them in skew-rolls—that is to say, in rolls which are not parallel either to one another or to the bar or other material to be treated by them.

In the ordinary rolls, the bar to be rolled is put in at right angles to the rolls, which revolve in opposite directions. But in the Mannesmann tube mill both rolls revolve in the same direction, and the bar to be acted upon is placed between them lengthways, while, as before mentioned, the circumferences of the rolls are not parallel to one another. These rolls revolve at about 200 to 300 revolutions per minute, and by their action on the hot, and therefore plastic steel, stretch it and make a hollow in the centre.

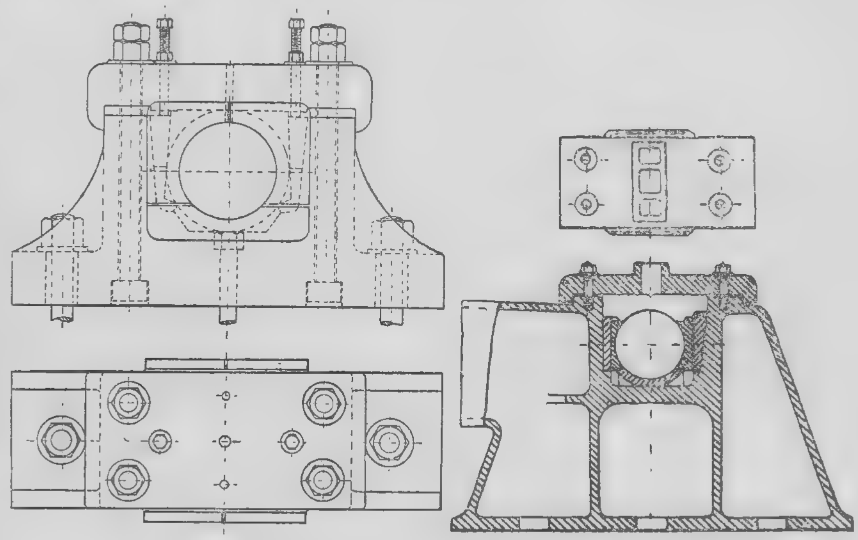


FIG. 215.—DESIGN, ETC., OF STATIONARY ENGINES.—FIG 216.

To explain why the rolls acting in this peculiar manner have the effect on the bar of steel subjected to their action, of converting it into a tube, I cannot do better than quote from a paper by Mr. Frederick Siemens read before the British Association at their Bath meeting. He says: "To obtain a simple forward spiral action of the bar, the length of the rolls is immaterial; it will take place when the rolls are reduced to the form of thin discs. Supposing the discs to be infinitely thin, or, what is the same thing, that their outer edges are reduced to a mathematical line, and no sliding motion takes place, the bar must still move forward spirally, its spiral velocity being equal to the velocity of the outer circumference of the discs. If, instead of one pair of such thin discs, several pairs of discs of regularly increasing diameters are made to revolve on the same axis, the outer circumference of each disc will revolve with greater velocity than that of the preceding one."

The same bar is, however, drawn forward through the several pairs of discs, and thus as each part of the bar enters successively a more advanced pair of discs, the velocity with which that portion of the bar rotates increases, and it is drawn forward by each succeeding pair of discs as they catch hold of it with ever-increasing speed.

It will be understood that in the case of a bar passing through such a series of discs, no slipping being possible, the material with which it is composed cannot retain its original area or volume. The diameter of the bar being regulated by the discs, while simultaneously a violent stretching action is carried on, the material required can only be drawn from the inside of the bar, and thus a hollow space is formed.

Instead of this peculiar arrangement of discs, a conical, or rather conoidal pair of rolls, which amount to the same thing as the discs, considered as joined together, may be provided. It follows that a bar or rod of suitable dimensions, which is passed through the Mannesmann rolls, will, provided its substance is sufficiently homogeneous and plastic, undergo a violent twisting and stretching action, the fibre being spun as is the fibre in a rope, on account of which the process may appropriately be called a "torsional" process. The bar, in its passage through the rolls, is twisted as a thread is twisted in a spinning machine. As, however, it cannot be fed from the outside, as in the thread, and, as has been said, the diameter cannot be reduced on account of the action of the rolls, it is forced to draw on the interior for a supply of material.

I will attempt to explain the process in another way. The tube is made thus:—A bar is placed between conoidal rolls at the part where, their diameter being least, the speed at which they move to make a revolution is also the least. The rolls seize the bar and draw it into contact with the parts of the cones which move more and more rapidly, though, owing to the way in which the rolls are set, the space left between them for the passage of the bar decreases slightly. Slight, however, as is this decrease in the space between the rolls, a certain amount of material has to be shifted. The action of the rolls prevents this material from being taken from the outside of the bar, and consequently it is drawn from the interior; hence the tube.

Soon after entering the rolls a small central fracture is formed, which widens out to a hollow space as the increased stretch is made to take effect in an increased twist acted on from the surface.

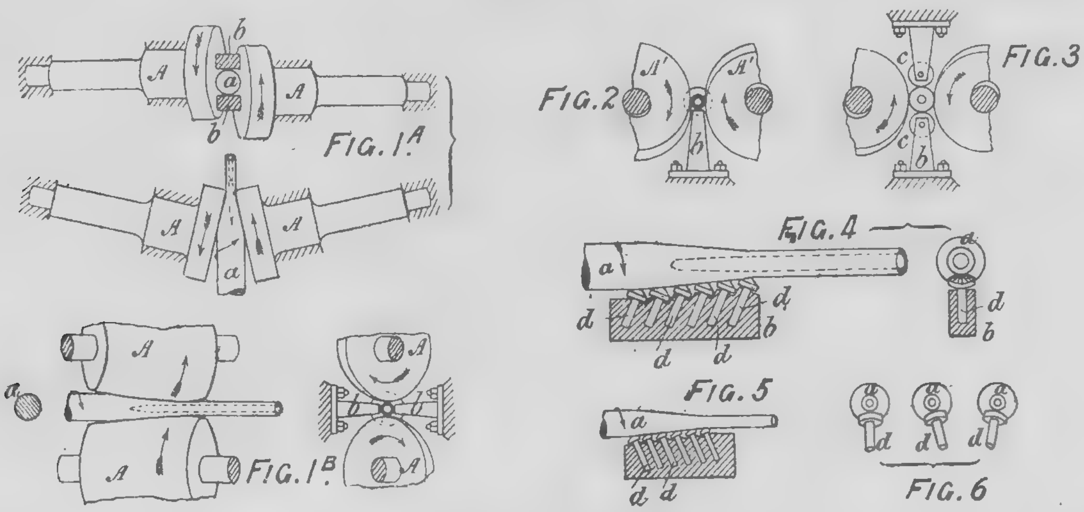
Though the bar is thus converted into a tube by the action of the rolls, and their action only, a mandril is generally used to finish and smooth the interior and enlarge the tube. This use of the mandril has led to the erroneous belief that it is necessary to form the hole in the bar. No machine, however, could stand the strain if it were attempted to force a mandril longitudinally through a solid bar of hot steel. Just sufficient power is used to form the hollow in the bar from the action of the rolls outside, and into this hollow the mandril enters, smoothes the inside, and when required enlarges the tube. Thus we have the strange experience in rolling that by one operation the bar is made hollow, and also longer and wider than when it enters the rolls a few seconds before.

I have previously stated the first patent relating to this process of "tube manufacture" was granted to George Walter Dyson and Henry Arthur Hall on 31st October, 1870, for "improvements in rolling finished circular metal rods or tubes," which is illustrated in Fig. 1. A further development of this invention was patented by Herbert John Haddan, January 27, 1885. It relates to the making of pipes or tubes out of solid metal by passing the blank once or several times through rollers, and while doing so, imparting to such blank a rotatory motion between the rollers. This invention was further improved upon by Reinhard Mannesmann and Max Mannesmann, of Remcheid, Germany, for which Letters Patent were obtained August 3, 1886, "for improvements in the construction" and "use of apparatus for the manufacture of pipes or tubes." This patent, which is the most important of the "Mannesmann" process, and the principle, quoted from Mr. Siemens' paper, is described in the specification as follows:—

Between two rollers, the axes of which are placed at an angle to one another, a

block of metal A is made to pass, having a rotatory and at the same time a longitudinal motion imparted to it. In Fig. 1A the rollers are shown as being placed side by side; in Fig. 1B as being placed above one another; and in Fig. 2 also they work beside each other. In all three arrangements one roller revolves in a direction opposite to that of the other. In Fig. 1A the working takes place between the lateral, and in Figs. 1B and 2 between the circumferential surfaces of the roller. Towards the egress the distance of the rollers from one another become less, so that the piece of metal performs a spiral motion on emerging from the rollers A A, A^1A^1.

For the purpose of regulating the motion the blank is provided with lateral guides *bb*, Figs. 1 and 2, or friction rollers *c*, Fig. 3. The guides may also be longitudinally arranged, as shown in Figs. 4 and 5. These guides *d d* are made to rotate within the guide bar *b*. The surface lines of the



MANNESMANN PROCESS OF TUBE ROLLING.

guides *d d* may be rising towards the egresses of the blank, as shown in Fig. 4, or towards the ingress thereof, as shown in Fig. 5, or else they may be slanting in any direction, as shown in Fig. 6. The rotatory motion may be imparted to these guides by the friction produced upon them during the progress of the blank, or by any other suitable means, and owing to the surfaces with which the blank is brought in contact varying constantly, the excessive heating is obviated, and the surfaces may be readily kept cool by water dropping thereupon, or by other methods.

When the blank *a*, Figs. 1A to 3, has been sufficiently heated to make it soft enough, or if it be possessed of a sufficient degree of plasticity in ordinary temperature, and if during the passage through the rollers a sufficient reduction of dimensions takes place, a transfer of material from the centre towards the circumference of the blank is effected, and by external compressions or by displacement of molecules, a pipe is formed without the use of a core. Such would, for example, be the case if a cast-steel billet of 1·8in. be worked, and if the spiral threads performed by the blank be not too distant from each other, so that, when the axis of rotation of the blank forms an angle of 6° with the roller, the blank of 1·2in. advances 0·08in. at every revolution. The dimension of the hollow formed depends upon several circumstances, to wit:—

1. The proportion between the speed at which the rotation takes place and the progress of the blank. The hole will be largest when there is a certain proportion between the circular and rectilinear motion, which is determined by the nature of the material, the temperature, the superficial area of the rollers, as well as their speed, dimensions, and positions, the most suitable proportion being in each instance ascertained by practice. As the proportion varies the hole becomes less, until it disappears altogether and the blank remains solid.

2. The position of the blank between the rollers. The more central the position of the blank, the larger the hole will be, and conversely, until it disappears altogether, when the blank occupies a certain lateral position, determined by the nature of the material and by the temperature.

3. The proportion in which the dimensions of the blank are being reduced. The formation of the hole only commences when a certain reduction takes place, and the size of the hole and the proportion between its diameter and the external dimensions of the blank increases up to a certain limit as the size of the blank is growing less.

4. The angle at which the surfaces of the rollers work together.

5. The twist of the fibres, and

6. The configuration of the surface of the rollers. Round or angular projections, whether parallel or at an angle to the axis of the rollers, facilitate the formation of the hollow, because they tend to increase the superficial area of the roller. The adjustment of the position of the rollers required for the purpose of varying the size of the hole may be effected while the work is going on or during the intervals by means of any suitable levers or hydraulic arrangements.

(*To be continued.*)

Arrangement of Cylinders and Cranks in Triple-expansion Marine Engines.*

THERE is considerable diversity of opinion amongst engineers with regard to the above, as is evidenced by the many different designs seen on board our modern steamships. It is mainly with a view to elicit opinions from the members of this Institution that this paper is written, and not to advocate any special type. The merits and demerits of each design are brought forward as they have occurred to the author, and, in order to arrive at some conclusion as to what arrangement is the best, it is hoped that any of the gentlemen here present who have given the subject a little thought will state their views for the general edification. The term "triple-expansion" is in itself a misnomer, for the steam is expanded 16 to 20 times in the system of engines which the above term is intended to designate. It, however, took the popular favour when the type first came in vogue, and has now become the universal title by which the three-cylinder compound is known. It will be borne in mind that the sequence in which the cylinders are arranged does not necessarily imply that the cranks follow in the same order. The high-pressure is, of course, the leading crank, but it does not follow that the next to turn, the centre, will be the intermediate, even if the intermediate cylinder be the next in the series. In this connection also, when speaking of crank angles, it will be understood that the engines are going ahead, for when going astern the relative positions of the other two cranks in respect to the high-pressure are transposed.

As there are very few who advocate the tandem system in triple-expansion, it will not be considered in this paper. As a cheap method of tripling ordinary compounds without adding to the length of the engine-room, the addition of a high-pressure cylinder on the top of one of the others was advantageous, and in some cases new sets of triple engines were designed on this principle; but it never received much favour, and now is seldom fitted in new vessels. The impossibility of equally dividing the stresses over the two cranks, and the difficulty of providing access to the pistons of the tandem cylinders, are the two principal objections to its extended use. The most common form in which the cylinders are arranged is where the high-pressure is followed by the intermediate, and that by the low-pressure, with the cranks in the same order. In this plan there is little to distinguish it from the ordinary compound beyond the addition of another cylinder, with its crank, rods, etc. This has the merit of simplicity, and as such is advisable for small vessels in Eastern waters, but is not the most perfect from a scientific point of view. The fore-and-aft space taken up is greater than with other types, especially when fitted with the common link and valve motion, and usually the receivers are of insufficient capacity for perfect distribution of the steam, causing variation of back pressure and correspondingly variable stresses on the crankpins. Where the intermediate crank follows the high-pressure the valve (intermediate) is open full to steam during the time the high-pressure exhaust is closed; and while steam is expanding in the intermediate cylinder, after cut-off, the high-pressure is exhausting and accumulating pressure in the receiver. To nullify this variation of back pressure it is necessary to design the receivers larger than would otherwise suffice, producing a greater "drop," and consequently greater inefficiency.

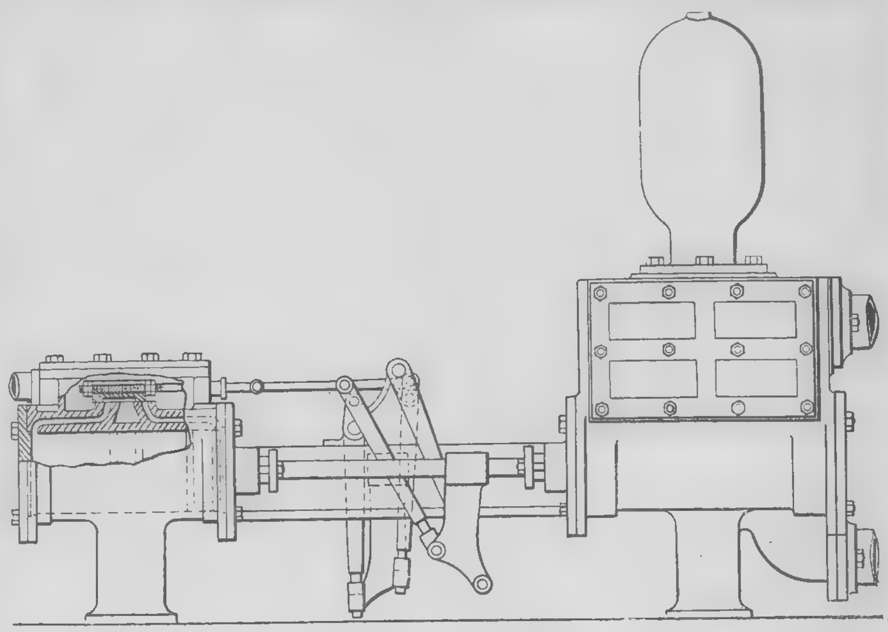
It is strange that in these days of scientific research so many engines should be made with the exhaust passages encircling the cylinders. After the steam has done its work it issues from the cylinder at a greatly reduced temperature to that it bore when it entered, and this comparatively cold steam is led round the outside of the cylinder walls, providing a most efficient condensing apparatus for the hotter steam within. The loss by liquefaction must be enormous, though there are some compensating advantages which must not be overlooked when condemning a design *in toto*. It makes a neater engine to have the two smaller cylinders each in one casting with its exhaust passages; and the heat which is robbed from the cylinders by the exhaust steam is given up to the low-pressure cylinder and does useful work there. Consequently, in engines of this description, the low-pressure receiver pressure is high, the horse-power indicated is greater than by the other two engines, and the balance of power, therefore, not so evenly divided as in other designs. In the design sometimes seen, where the high-pressure cylinder is in the middle, a steam jacket may be fitted round it and also the intermediate, making a very compact arrangement. Where the jackets are not fitted the engine presents a very unsymmetrical appearance, especially when viewed from the top; but the advantage is obtained of being able to design capacious steam chests, as the middle engine must be spread in a fore-and-aft direction in order to accommodate interchangeable crankshafts. This, however, gives it the same disadvantage mentioned in the first example, in that the longitudinal space occupied is very great. Where a minimum of space is available the valves should be placed at either the back or front of the engines, preferably the former, on account of providing an open and light starting platform and leaving room for reversing gear and other details. The most symmetrical arrangement is to place the low-pressure cylinder in the middle, flanked by the high-pressure and intermediate-pressure, the sequence of cranks in the same order, and all the valves at the back. In this design the fore-and-aft space taken up is less than in a compound of greater power, and the crankshaft can be made in three sections, reversible and interchangeable, so that one spare crank is sufficient to be provided for all ordinary contingencies. The only fault in this arrangement is that in case of breakdown there are more facilities for continuing the voyage, and temporary repairs or modified conditions can be more easily applied when the low-pressure cylinder is situated aft.

(*To be continued.*)

* Abstract of a paper read by Mr. W. G. Winterburn, M.I.M.E., before the Institution of Engineers and Shipbuilders at Hong Kong.

Improved Duplex Steam Pump.

THE accompanying illustration shows a somewhat novel form of duplex steam pump, which has been specially designed for working at very high speeds. The principal feature of the pump is the method employed for actuating the slide valves, and this is accomplished in such a manner as to keep both pistons working at the same time, much in the same way as in a pair of steam engines with cranks at right angles. This is accomplished by giving a compound motion to the slide valve of each cylinder, by means of levers actuated by the piston rods of each cylinder, and causing the valves to give a constant lead to admission, cut off, and exhaust of the steam, as in a rotative engine. That the valves very effectually regulate the stroke of the pistons is evidenced by the fact that with a clearance of ¼in. between pistons and cylinder covers, and each piston travelling at a speed of from 300ft. to 500ft. per minute, no striking of the cover occurs when the pump fails to draw water, or when the suction pipe is removed.



IMPROVED DUPLEX STEAM PUMP.

For moderate lifts and surface pumping, and for air and circulating pumps, the steam is cut off at about $\frac{7}{12}$ of the stroke of the piston, each piston running at from 300ft. to 500ft. per minute, at which speed the pumps deliver a continuous stream of water, no pulsations being observable, without either noise or shock, and, on account of exhausting expanded steam, without the objectionable noise due to emitting steam at high pressure. The only feature peculiar to the pump part of the engine is that the valves, waterways, and pipes are of very large area so as to give as free a passage as possible to the water when working at high speeds.

It is claimed that this pump is capable of being driven at five times the speed of an ordinary duplex pump with a correspondingly increased delivery; also that the length of stroke and the amount of lead is constant. Further particulars may be had from the inventor, Mr. T. Holehouse, 46A, Market-street, Manchester.

IMPORTANT BEDS of manganese have been discovered in Transcaucasia.

Metal-cutting Tools.

(*Continued from page 102.*)

The Roughing Cutter.—The cutters for all bars in which they are carried by the transverse slot are of four kinds for general use, and others as required for special work. The first, or roughing cutter, having the function of the diamond-point lathe tool, may, of course, be of the general characteristics of the latter—that is, as to angle of cutting edge, clearance, etc. It is made of flat bar steel, and need not be forged, as its shape may readily be made by filing. It should be of a thickness to fit snugly in the slot, and the width enough less than the length of slot to allow room for a square taper key, by which it is held in the bar. By some the corresponding taper is made in the end of the slot, and the cutter may then be parallel. It is much better, however, to make the slot parallel at the ends, for the reason that it is necessary to be able to put the cutter in to face either way, and the tapered ends interfere with doing so. The back edge of the cutter can as readily be made to suit the key, which prevents any such difficulty, though, of course, it can be used but the one way, and another must be provided when the setting needs to be reversed.

In setting for the cut, the key should be driven firmly enough to hold the cutter against any danger of slipping, and the adjustment made by tapping the latter in or out, as required, and trying the resultant cut with the caliper; after which the key should be firmly driven home. Of course, for the following cuts, if they be necessary, the cutter must be set out still further, or if it be too short to reach for the required diameter it must be replaced with a longer one. As it is always desirable to use as large a bar as will go into the existing hole at starting, to gain as much stiffness as possible, the first cutter cannot be of a length much greater than the diameter of bar, and consequently it is apt to fall short if the size of hole is to be greatly increased.

Taps and Dies.—Taps and dies for cutting screw threads are of two classes—machine and hand. While they are similar in most other points, in respect to form of thread they differ considerably—that is, according to the accepted practice,—though the necessity for the difference is not entirely apparent. Whether for machine or hand use, the construction of the tools should be such as to admit of their being capable of continuous cutting without requiring an undue amount of power, and giving a resultant thread clean, bright and sharp, and true to size. As in all the tools previously described, the angle of cutting edge and clearance are the principal factors by which the cutting properties of taps and dies are governed; and if these be correct, the operation of thread cutting is by no means laborious or difficult. The time is not so far behind us but that it may be within the recollection of a middle-aged machinist when these tools were of such crude and imperfect character as to appear veritable monstrosities as compared with those of modern make.

A tap was usually a steel screw, whose thread, while approximately a V form, was of almost any angle except the correct one, while the size varied from the standard to a corresponding degree. The method most commonly used for making the teeth was to file the tap square—going as far below the bottom of thread as would leave a small portion entire. Some mechanics, more than ordinarily particular, would file a shallow groove either with the corner of a square file or a round one. The tap was then tempered, and was ready for service. Clearance was a thing unknown, and in consequence to use these tools was veritably to earn one's bread by the sweat of his brow. While the reason is not apparent, it is a fact that the necessity for the application of cutting to threading tools of this class did not appear to be appreciated by the majority until long after it had become universally recognised as a necessity in the construction of almost all others.

It need not be said that the thread resulting from the use of improperly-made taps and dies is deficient in the important element of strength, as it is not cut but squeezed into shape, and as a consequence the metal is so strained and tortured as to render stripping comparatively easy. The strength of a properly-cut thread should always be sufficient to enable it to remain intact under a tension strain which would cause the rupture of a rod or bolt whose diameter is equal to that of the outside of the thread, provided the length of thread in the nut or tapped hole be equal to its diameter. Its wearing qualities also are much greater, from the fact that the surfaces are clean and smooth, and afford a maximum amount of bearing.

The standard taps and dies made by any one of the numerous concerns engaged in the manufacture of this class of specialities are correct in all essential features of construction; and by their use the cutting of threads may be accomplished with a minimum of power—only so much being required as is actually necessary to do the cutting—without a useless expenditure to overcome a frictional resistance, possibly double that actually applied to the cutting. From the fact that as an article of manufacture the various operations necessary in their construction may be done by the use of the most improved special machinery, these tools can be produced and sold at a profit at a price far below the actual cost of making them in the tool-room, where the possible facilities are necessarily far inferior. As a rule, therefore, it does not pay for even the best-equipped shops to make standard sizes and threads, although for special work it may be cheaper to make than to buy them. As there are many shops, however, whose location is out of convenient reach of the market, and as this renders them dependent on their own resources, the making of these tools becomes a matter of necessity. Others who might conveniently buy still prefer to make them.

But whether from necessity or choice, if it be the practice to make them in the shop, the means of maintaining the desired accuracy should be provided. These consist of carefully-cut male and female threads, true to the standard size and angle, which, in order to ensure the necessary durability, should be hardened and tempered only sufficiently to relieve the shrinkage strains. Of course, like any other standard gauge, they should never be used except for the specific purpose of gauging, as otherwise there is danger of their accuracy becoming seriously impaired. Taps—threads of very small sizes—should always be cut in the lathe. The chasing tool should be carefully ground to the required form and angle, and so set as to give the cut its exact shape. When nearly down to size, the feed should be extremely light and the tool keen, using plenty of oil to ensure smooth, clean work. The size, after each of these finishing passes, should be tested by the gauge. As previously explained, in chasing threads the point will invariably be larger where the cut starts in, and it is best to give it a very slight taper for a few threads, to ensure against being misled by this peculiarity. In trying to size by gauge a wrench should never be used, as any application of force will destroy the accuracy of fit. By placing the gauge in the vice, all the power necessary can be applied by using both hands on the corner, and except on larger sizes this should require but very little exertion.

It is a very common practice to polish the thread, after cutting to size, by means of a pointed emery stick. This, however, is not only unnecessary, but undesirable. The finish left by the tool, if it be in proper order, is perfectly smooth and bright, and the use of emery only tends to impair or destroy the perfection of the work instead of improving it. For square threads, it is well to make a template gauge of one thread and one space, as it greatly facilitates the cutting and prevents the liability to mistakes which may happen if the female thread gauge be depended on entirely. This is owing to the fact that there are several surfaces of contact, and the binding might be in one, while the reduction was being made in another which was already sufficiently small. It is important that the two sides of the thread be finished separately by some form of side-cutting tool, and as a last operation the bottom be finished with a keen, well-cleared square nose tool, whose edge is set perfectly parallel with axis of the tap. The grooving for all taps is best done in the milling machine, with very slow feed, as there is much less danger of straining or distorting the thread by the cut than where the work is done by planer or shaper, though, of course, the latter may be used with perfectly satisfactory results if proper care can be exercised in feeding. When the necessary facilities are available it is well to finish the groove, after hardening and before tempering, by grinding with a fine emery wheel on index centres. In doing this, however, particularly with a full V-thread, the greatest care must be exercised to prevent heating, and consequently drawing the temper of the points of teeth below the degree of hardness required. As this might readily occur without being perceived, it might result in spoiling the tap the first time it was used by crushing down the points beyond repair.

(*To be continued.*)

Sir George Findlay.

We record with regret the death of Sir George Findlay, the general manager of the London and North-Western Railway, which occurred on the 26th inst. Sir George was born in 1829, and entered the railway service in 1845, and after being engaged on various Welsh lines finally became manager of the Shrewsbury and Hereford line. The latter line was acquired by the London and North-Western Railway, and after this Sir George's rise was rapid. He became chief goods manager, and in 1874 was appointed traffic manager of the line, with which he was henceforth to be intimately associated. In spite, however, of the great responsibility which the position of general manager of such a line entailed, Sir George found time to join in the discussion of railway questions at the Institution of Civil Engineers, of which he was an associate member. To the proceedings of the International Railway Congresses both at Paris and St. Petersburg he contributed valuable papers. Out of a lecture on the "Working of an English Railway," delivered at the Chatham School of Military Engineering, grew the book on "The Working and Management of an English Railway," which has received notice in our columns. More recently, as Lieutenant-Colonel of the Railway Volunteer Staff Corps, he lectured at the United Service Institution on "Railways as a Means of Defence."

Metal Trade Memoranda.

A basic open-hearth furnace has been put in blast at the Rasselstein Ironworks, Neuwied, Germany.

A phosphor-bronze casting of the stem of the "Renown," weighing about 18 tons, has been made at Pembroke.

During the first six weeks of this year 20,000 tons of iron ore have been despatched from Gellivara to Lulea, Sweden.

According to the statistics supplied by Messrs. Henry R. Merton and Co., the stocks of copper in England and France on the 15th inst. amounted to 51,242 tons, as against 52,920 tons on 28th February. For the same periods the quantities advised from Chili and Australia amounted to 4600 and 4500 tons respectively. The deliveries for the past fortnight were 3344 tons.

The return of Mr. Waterhouse to the Board of Conciliation for the northern manufactured iron and steel trades shows marked depression, the production of 22,000 tons being less by 14,000 tons than for January and February last year. The plate and angle branches show the greatest decline, because of the reduced shipbuilding operations. The net average price of rails, bars, plates, and angles, £5 1s. 2¾d., gives a reduction on the November and December return of 2s. 11½d. per ton, and reduces ironworkers' wages by the sliding scale 2½ per cent.

New Companies.

English Electric Carbon Company Limited.—This company was registered on the 18th inst., with a capital of £10,000, in £10 shares, to erect and establish works for the manufacture of electric light and other carbons at the Smelt, near Brymbo, Denbigh, and to carry on there the business of electric light manufacturers. The rules of Table A generally apply. Registered office, The Smelt, Brymbo, Denbigh.

Pneumatic Patents Company Limited.—This company was registered on the 17th inst., every member becoming liable for a sum of £1 in case of liquidation, to purchase, use, work and exploit any patents, of any nature whatsoever; and to carry on the business of machine manufacturers, electricians, mechanical engineers, suppliers of electric, steam, pneumatic, or other forces for the purposes of light, heat, and motive power. The rules of Table A generally apply. Registered office, Dock House, Billiter-street, E.C.

Bates' Patent Syndicate Limited.—This company was registered on the 18th inst., with a capital of £13,200, in £5 shares, to purchase inventions for improvements in the manufacture of iron or steel, and in particular in existing processes for converting iron or low-grade steel into high-grade steel, to enter into an agreement with the Bates' Steel Syndicate, and to use and develop any patents acquired. Registered without articles of association, Queen Anne's Mansions, St. James's Park, S.W.

Traction Syndicate Limited.—This company was registered on the 22nd inst., with a capital of £10,000, in £100 shares, to purchase patents, brevets, or licences as to any invention which may seem to the syndicate capable of being profitably dealt with; among other things to construct, improve, maintain, work, and control railways, reservoirs, roads, water-courses, etc. The number of directors is not to be less than 3, nor more than 7; qualification, £100. Registered by Faithful O. Owen, Victoria-street, S.W.

Lloyd's Ironstone Company Limited.—This company was registered on the 20th inst., with a capital of £50,000, in £10 shares, to acquire from S. Lloyd and W. Lloyd, M.P., the business carried on under the style of Lloyd's Ironstone Company, and to continue the business of miners and dealers in ironstone, etc. The number of directors is to be 3: S. Lloyd, W. Lloyd, M.P., and S. J. Lloyd being the first; qualification, 100 shares; remuneration, £200 per annum each. Registered by Sharpe, Parker and Co., 12, New-court, Carey-street, E.C.

Thomas Holcroft and Sons Limited.—This company was registered on the 22nd inst., with a capital of £120,000, in 11,500 shares of £10 each, and 1000 shares of £1, to acquire and take over as a going concern the business of an iron-founder and hollow-ware manufacturer, heretofore carried on at Ettingshall, Staffordshire, by Thomas Holcroft, under the style of Holcroft and Sons, and to continue the business of iron-founders, enamellers, etc. Qualification, £500; remuneration to be sanctioned by a general meeting of the company. Registered by Jordon and Sons, 120, Chancery-lane, W.C. Registered office, Ettingshall, Wolverhampton, Staffordshire.

Blum's Patent Gas Producer Limited.—This company was registered on the 17th inst., with a capital of £5000, in £5 shares, to acquire from Johannes Blum the colonial and foreign letters patent (No. 5097), brevets d'invention and the like grants, to exercise an invention for the production of permanent combustible gas by the action of superheated steam on incandescent carbonaceous matter; to adopt and carry into effect an agreement, and to use and develop the above-mentioned patent. The number of directors is not to be more than 7, nor less than 3, the first being elected by the subscribers to the memorandum of association. Registered by R. H. Bentley, 30, Essex-street, W.C.

James Hawley Limited.—This company was registered on the 21st inst., with a capital of £5000, in £5 shares, to acquire and take over as a going concern the business of an engineer, iron and brass founder, etc., now carried on by Mr. James Hawley at the Derby Works, Carruthers-street, Liverpool, under the style of "James Hawley," to enter into a certain agreement made between J. Hawley and C. J. P. Cooper, and to follow the trades of engineers, boiler-makers, etc. The number of directors is not to be less than 3, nor more than 5, the following being the first: J. Hawley, C. J. P. Cooper, and H. Thomas; the qualification of Messrs. Hawley and Cooper is £1500, and that of other directors £100; remuneration to be decided in general meeting. Registered by J. H. Hunter, solicitor, Liverpool.

Otis Elevator Company Limited.—This company was registered on the 20th inst., with a capital of £50,000, in £10 shares, to adopt and carry into effect an agreement dated March 13, 1893, made between the American Elevator Company and J. C. Bull, for the sale of the goodwill of the business of manufacturers and dealers in hydraulic, electrical, and steam elevators and other machinery, carried on by the American Elevator Company in Europe, Asia, and Africa, all inventions and other patent rights owned by this company; an agreement made between Otis Brothers and the company and J. C. Bull, on behalf of the company, with reference to improvements in those inventions; and also an agreement made between the Brush Electrical Engineering Company Limited and J. C. Bull, relating to the manufacture of elevators and other machinery; and to carry on the business of manufacturers of and dealers in hydraulic, electric, and steam elevator lifts and other machinery. The first directors (whose number is not to be more than 6, nor less than 3) are to be W. A. Gibson, N. S. Russell, E. Wood, H. Sherley-Price, and R. H. Thorpe; qualification, £250; remuneration, £100 per annum each. Registered by Ingle, Cooper and Holmes, 20, Threadneedle-street, E.C.

The Metal Market.

PRICES CURRENT.

LONDON, March 27.

Copper opened with cash business at Friday's values, but with a quiet tone, and the placing of selling orders, mainly on American account, afterwards gave way. Transactions included cash at £45 5s. 9d. to £45 7s. 6d., three months at £45 16s. 3d. to £45 13s. 9d., early May at £45 10s., and middle June at £45 12s. 6d. The close was steady, with sellers at the quotation and buyers at 1s 3d. less, or a decline of 3s. 9d. on the day. Sales 400 to 500 tons. Settlement price, £45 5s. A moderate carrying business was done early at a difference of 8s 9d. English tough, £48 to £48 10s.; best selected, £49 10s. to £50; strong sheets, £57.

Tin opened at £95 for the beginning of May, but the market, though quiet, was firm, owing to a demand on American account. After the end of May had been done at £95, trading became decidedly slow, but best made £94 10s., and three months closed with buyers at 7s. 6d. above Friday's official value. Public sales only covered 25 tons. Settlement price, £94 10s. English ingots, £97 10s. to £98.

Pig Iron began with buyers of Scotch cash at ½d. advance, but sellers were reserved all day, and after an inactive market Scotch closes 1d. higher, and hematite 1½d., but Middlesbrough is partially ½d. down. Settlement prices:—Scotch, 40s. 10d.; Middlesbrough, 34s. 4d.; hematite, 45s. 7d.

Tinplates firm for early delivery. I.C. cokes, f.o.b. London, 12s. 9d.; Liverpool, 12s. 3d.; Swansea, 11s. 9d.

Lead has a quiet market at £9 16s. 3d. sellers. English, £9 17s. 6d. to £10.

Spelter is quiet but steady, at £17 17s. 6d. sellers, April shipment.

Zinc Sheets.—Silesian a shade easier at £20 15s. ex ship. Belgian quietly steady; V.M. brand, £20 17s. 6d., ex ship, and £20 15s. f.o.b. Antwerp, sellers.

Official Closing Quotations.

	To-day.					
Copper—	£	s.	d.	£	s.	d.
G. M. B.—Cash	45	6	3—	45	13	9
" Three months	45	13	9—	46	1	3
Tin—						
Fine foreign—Cash	94	10	0—	95	0	0
" " Three months	91	10	0—	92	0	0
Australian—Cash	95	0	0—	95	10	0
Pig Iron—					s.	d.
Scotch warrants—Cash					40	10
" One month					41	0
Middlesbrough—Cash					34	4
" One month					34	6
Hematite—Cash					45	7½
" One month					45	10

GLASGOW, March 27.—Business on the pig-iron market was very quiet, not more than

6000 tons, wholly Scotch, selling, 4000 at 41s. 0½d. one month open, the balance being at 40s. 10d. and 40s. 10½d. cash. The general tone was firmer, sellers' prices of Scotch and Cleveland closing 1d. up, and hematite 4d. better. The shipments of Scotch last week were 7510 tons, an increase of 1279 tons on the corresponding week of last year.

QUOTATIONS:—

	Scotch.		Middlesbrough.		Hematite.	
	Cash. s. d.	1 m'th. s. d.	Cash. s. d.	1 m'th. s. d.	Cash. s. d.	1 m'th. s. d.
Highest ..	40 10½	41 0½	34 4	34 6	45 7½	—
Lowest ..	40 10	41 0	34 4	34 6	45 7½	—
Close	40 10	41 0	34 4	34 6	45 7½	—
Prev. close	40 9	40 11	24 4	34 6½	45 6	—

Official Gazette.

Partnerships Dissolved.

J. D. F. ANDREWS and H. H. GRAY, under the style of J. D. F. Andrews and Co., Parliament-street and Marsham-street, S.W., electrical engineers and electrical manufacturing contractors and agents.

H. C. ASHWORTH, G. H. HARDMAN, and W. FETHNEY, under the style of H. Ashworth and Co., Bury, general ironmongers and electrical and heating engineers; as far as regards W. Fethney.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Adjudications.

AUSTIN HERBERT, Hull, late of Westhorpe, near Southwell, and Nottingham, out of business, late electrician.

LEONARD MANSFIELD, sen., and LEONARD MANSFIELD, jun. (trading as Mansfield and Son), Cardiff, millwrights and engineers.

FREDERICK SILVESTER (trading as F. Silvester and Co.), Newcastle-under-Lyme, ironfounders.

Receiving Orders.

WILLIAM PARKINSON and ANDREW GREAME (trading as Parkinson and Greame), Wharf-road, and Manchester-road, Cubitt-town, E., millwrights and engineers.

LEONARD MANSFIELD, sen., and LEONARD MANSFIELD, jun. (trading as Mansfield and Son), Cardiff, millwrights and engineers.

GEORGE PARTRIDGE, West Bromwich, machinist.

Letters to the Editor.

*** *We do not hold ourselves responsible for opinions expressed by correspondents.*

*** *The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

*** *Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

AVOIDANCE OF SMOKE.

To the Editor of THE MECHANICAL WORLD.

SIR,—Mr. Nicholson's letter in your issue of the 17th inst. deals with smoke only in so far as it is produced in the generation of steam power; and if experience bears out his statement that manufacturers, by the use of gaseous fuel, could save 100 per cent. per annum on the cost of making the alterations necessary in changing from the present process of firing to the other, then I think the sooner that manufacturers are made aware of the fact the better. It would be very interesting to have the opinion of the firms in Yorkshire at present heating their boilers by gas, to which Mr. Nicholson refers: as to whether, in their experience, the process is safe, and so economical.

Supposing that this part of the problem was satisfactorily solved by gaseous fuel in the manner referred to, there would yet remain the more difficult part to be dealt with — namely, the smoke produced by domestic fires. It was in this connection that I thought Mr. Nicholson, in his letter in your issue of the 24th ult., advocated the making, by Corporation, of gas at 6d. per 1000 feet, and coke at 10s. per ton. As such gas could not be used for lighting, another set of pipes would require to be laid in the streets, and fresh fittings made in the houses before it could be supplied. But looking to the rapid developments that are being made with electricity, and the extent to which it is likely to come into competition with gas, Corporations are not likely to incur the expense of laying down another line of pipes to supply heating gas. When the electric light is cheapened and comes into general use in our homes, then will Corporations be able to use the existing pipes for the supply of the best gas for heating purposes. As that time, however, may be a long way off, the question arises, What is the best that can be done now for the prevention of smoke from domestic fires? The most feasible idea seems to be the burning of coke with the gas at present obtainable—the gas only to light the coke or brighten up the fire when dull. The main objection to this system is the large amount of light powdery ash left from ordinary gas coke, which, when the grate is cleaned, flies about and is a nuisance in itself; but this, perhaps, might be got over by the production of a better coke.

As this subject is one affecting the welfare of the great mass of our population, it is to be hoped that attention to it will not be allowed to drop until means are adopted whereby one of the greatest natural blessings—pure air—will have free course.

Glasgow, March 20. W.

Miscellaneous Items.

It is proposed to construct an electric tramway between Odawara and Atami, Japan.

The unburned ends of arc-light carbons are said to make excellent fuel when mixed with anthracite coal.

During the year 1892, 269 boiler explosions occurred in the United States, causing the deaths of 298 persons, and injuries to 442 others.

The system of pneumatic tubes between the Exchange and the General Post Office, Brussels, is to be extended to all the post offices in the district.

Coal has been discovered in the Eiffel region, near the Rhine, which is declared by experts to be Devonian anthracite coal, with an admixture of pyrites.

A new underground electric railway has been planned in Berlin. The distance is about 2½ miles, and it is proposed to cover the distance in seven minutes.

The construction of an elevated passenger railway at Cardiff, three miles in length, to connect Cathays Bridge with the Bute Docks, is at present under consideration.

A new kind of glass of remarkable brilliancy and clearness has recently been produced by a Swedish firm of glassmakers. It is said to be composed of no less than 14 different substances, of which boron and phosphorus are the most important.

Statistics show that Berlin is now lighted by 2916 arc lamps and 67,459 incandescent lamps. In addition to these there are 253 private installations, 170 of which are driven by steam and 83 by gas. These private installations supply 3287 arc lamps and 40,801 incandescent lamps.

A series of experiments have been made with a new rifle in the neighbourhood of London. The inventors assert that it is superior in all respects to the pattern of magazine rifle at present adopted by the Government. It was proved to be capable of discharging 80 to 100 rounds of ammunition per minute.

Two new vestibule cars have been put into the service of the London and South-Western Railway Company by the Pullman Company Limited. They are connected by a communicating passage, the length of each car being 58ft. 8in. over all, while the body is 52ft. long, 8ft. 7in. wide, and 7ft. 6⅝in. high inside as measured from floor to roof.

We are informed that the "Engineering and Mining Journal" of New York has opened a London office at 20, Bucklersbury, E.C., where business relating to the editorial, sales, and advertisement departments will be attended to. Our contemporary holds a high position in America as an authority on the principles and practice of metallurgy and mining, and will, doubtless, enjoy a wide sphere of usefulness and influence in this country, both in scientific and financial circles.

Transparent glass bricks have been employed for some time in walls of buildings to afford light at places where a window would interfere with the architectural plan, but this material has not been used to any extent for general construction purposes. It is now proposed to cast the glass, not necessarily transparent, into large blocks for buildings. As it is practically indestructible, non-absorbent, and therefore damp-proof, it is expected by this means to furnish coarse glass in suitable shape as cheaply as concrete or stone.

A novel experiment is being made in the postal service at Huddersfield. Letter-boxes are affixed to all the tramcars, and letters can be posted in them at all the termini, penny stages, and passing places, under the ordinary postal conditions; but if the trams have to be stopped specially for letters to be posted, a charge of a penny is made, and that goes into the conductor's box. The boxes are returned to the central tram office at the conclusion of every journey or at stated times, and are emptied by the postal officials every hour from 8-30 a.m. to 8-30 p.m., and then at 11 p.m.

Queries.

☞ **Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.**

☞ **Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.**

BRIGHTENING CHAINS.—Can any correspondent inform me what material to use in a shaker to brighten chains?—W. B.

WOOD'S AUTOMATIC PRESSURE RELIEF VALVE.—Required the address of Mr. W. Wood, the maker of the above.—B. and Co.

COST OF M.S. AND L. RAILWAY.—Can anyone inform me what was the cost per mile of the M.S. and L. Railway from Manchester to Grimsby?—LOW DROP.

IRON MANUFACTURE.—Required, particulars of the Husgafel process of making iron blooms direct from the ore.—F. C.

RAIL CROSSINGS.—Given the gauge and the angle of crossing of rails, what rule is generally adopted to obtain the radius of the curve and the rails?—R. A. J.

DYNAMITE.—Why does dynamite, when it explodes, penetrate farther and with greater force into a stone (or other substance) in a downward direction than gunpowder?—T. D.

METALLIC PAPER.—Could any reader inform me how paper can be prepared for taking indicator diagrams upon, with brass or iron point, to give a clear erasure with the slightest pressure?—M. H. M.

RUST JOINTS.—How can I stop leakage in a vertical joint (rust joint) in my hot-water pipes (low-pressure system) without cutting out the packing? Would any fluid cement percolate into the crevices and harden there?—B.

MAKERS OF BUILDERS' IRONWORK.—Can any reader furnish me with addresses of firms who are makers of machinery for making builders' ironwork, such as bands and hooks, cavity irons, etc.?—SMITH.

PUMPING PLANT.—Thanks to Mr. Hopkins for reply regarding pumping plant. Would he kindly say what he thinks would be the cost per day to do the same amount of work with oil engine of, say, best make?—J. P.

POWER RENTAL.—I am desirous of supplying steam power to a tenant from an engine driving his own works. How is the value of such to be ascertained, and what is the fair price for 100I.H.P. per week of 54 hours; also for 8I.H.P. similarly supplied power?

ELECTRICAL RESISTANCE.—Can any reader give me any information relative to the resistance offered to the passage of electricity by carbon rods and platinum wire? Is there a small work published on the subject? If I had formula, I could work out myself.—CARBON.

ELECTRIC TROLLEY.—I am in want of a trolley to carry about 3 tons a short distance on a good road nearly level. Can I get one to be self-propelling, and what would be the best kind of motor? I shall be glad if any reader can inform me where anything of this kind can be seen—CORN MILLER.

TUBBING.—What system ought to be adopted in the renewal of tubbing in a shaft which has become faulty in the middle of a length of tubbing 25 fathoms from the surface? Pit 15ft. and 100 fathoms deep? Kindly explain what method to use to secure the greatest safety and make the most permanent work.—J. M.

METALLURGICAL FURNACE.—Can any reader furnish me with a scheme for supplying the heating power necessary for a metallurgical laboratory situated in iron ore mining district, and where no gas is available? A small muffle furnace would be required, in addition to the ordinary heating power, and the fuel used is charcoal. Accommodation only required for one chemist.—H. S.

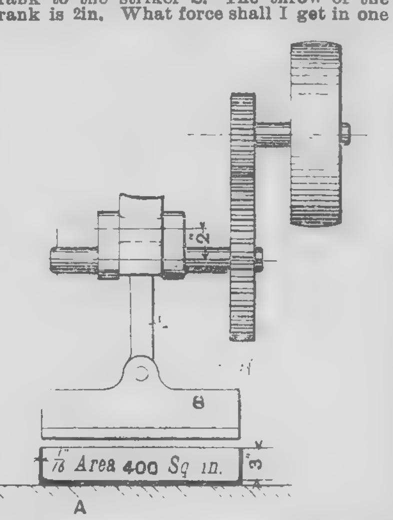
ELECTRICAL TRAP.—Can any reader of THE MECHANICAL WORLD inform me how to make an electrical trap for catching snakes, reptiles, etc.? I believe they are working successfully in India. Could I make one by enclosing a space and running bare wires round it, and charge by battery?—GEORGE PERKINS (North Queensland).

CONVEYING DEVICE.—I want to remove cut straw, ⅝in. long, from chaff cutter to a room distance 60ft., round one curve, at the rate of 5 tons per hour. What size tube shall I require, and how can I do it by means of a blast fan so that the chaff does not go through the fan? Would sanitary tubes do for the purpose, underground?—PUZZLED.

COUPLING DYNAMOS.—What is the effect of coupling up two dynamos in series, both of which are shunt wound, one yielding 100 ampères 10 volts, and the other 20 ampères 40 volts? What is the resultant output? Would it damage the 20 ampère machine? What is the effect, if the latter is put on a shunt, on the total E.M.F.?—K. P.

COVERING TANK.—I have to cover in a brick water tank 50ft. long, 20ft. wide, with rolled joist and concrete. Will some reader kindly tell me the size of rolled joist required, the distance they should be apart, and the proportion of gravel and cement, and thickness of concrete? It is an open tank, and will have no weight to carry on the top.—S. D.

STAMPING PRESS.—I have a press, as in sketch, driven by a 5in. double belt geared 4 to 1 and a connecting link L, which connects the crank to the striker S. The throw of the crank is 2in. What force shall I get in one



blow on the table A, and how shall I calculate the force if a fly-wheel is added, say 3ft. diameter and weighing 300lb.? The thickness of the material to be stamped is $\frac{1}{16}$in., the depth about 3in., and the area of stamp 400sq. in.—YOUNG DRAUGHTSMAN.

FACING SLIDE VALVE FACES.—I require a hand appliance, not expensive, suitable for getting up the faces of slide valves of portable, traction, and other engines, say when the valve face is some 3in. to 5in. from the valve-chest cover face. Are there no small hand-lever appliances which can be screwed on to a stud and used for working a broken file or similar tool?—NESCIENCE.

ENGINEERS' WAGES.—Would any reader kindly give me some information as to the wages at Cape Colony and Mexico for mechanical engineers?—REGULAR READER OF "THE MECHANICAL WORLD."

DYNAMO SHAFT.—I should be much obliged if the author of "The Design and Construction of Stationary Engines," or some other reader, could give me a formula (or refer me to any book where I could find it) for arriving at the size of shafts for dynamos and motors; given distance between bearings, weight of armature and pull on periphery of same in lb. Any information with respect to this would be much appreciated.—A YOUNG ELECTRICAL ENGINEER.

Replies.

☞ **Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent**

☞ **Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.**

H. T.—About 25ft.

BOILER.—It depends entirely upon the nature of the water used.

N. W.—See article in recent issues, "Hints to Intending Sea-going Engineers."

GREENWICH.—Messrs. Bryan, Donkin and Co. Limited, 55, Southwark Park-road, London, S.E.

BRASS.—We think Mr. Robert Brown, off Chapel Hill, Huddersfield, will be able to supply you.

A CONSTANT READER.—Several correspondents have asked for this work, but we believe that it cannot now be obtained.

E. N. G.—We cannot give you the precise wording, but think you will be able to find it in "Every Man His Own Lawyer," which you can consult at a public library.

J. T. B.—You do not say whether the 20lb. pressure is the mean effective, or only the mean forward pressure. Presuming it to be the former, the power will be 27I.H.P.

PALMERINO.—(1.) You will find rules in Box's "Mill Gearing" and Unwin's "Machine Design," vol. i. (2.) Make the bosses 16in. and 18in., and the flanges 27in. and 29in. in diameter respectively.

CONSTANT READER (Fife).—We think it might improve matters somewhat to fit in additional valves as you suggest. You do not give the speed of the troublesome pump, and if it is high this may account in some measure for the trouble. So far as the particulars given show, there seems no reason why the pump should not be made to work satisfactorily.

VILLA.—Your engine would pass $7 \times 7 \times 3\frac{1}{3} = 163$ cub. ft. per minute. At 50lb. pressure, or 65lb. absolute, this would be $\frac{163}{6 \cdot 5} = 25$lb. of steam per minute. Then, each pound of steam will require $\frac{1148 - T}{T - t}$ lb. of water, T being the temperature of the hot-well, and t that of the injection water.

ANXIOUS ONE.—Possibly the following will suit you: Powder and mix 12 parts of white fluorspar, 12 of unburned gypsum, and 1 of borax, and fuse the mixture in a crucible. Pour the mass out, and when cold rub it into a paste with water. Apply this with a brush to the inside of the vessel, and place this in a moderately warm place, so that the paste will dry uniformly. When dry, heat the vessel to such a degree in a muffle furnace that the paste which has been applied liquefies. When cold, the result will be a white, opaque enamel.

WASTE CLEANING, ETC.—(1.) I shall be much obliged for any information regarding the washing and cleansing of used waste and the filtering of oils; also the machinery necessary for same, cost, etc. (2.) The machinery involved in the grinding of bones to ash for chemical purposes, etc., or most economical way of doing same by furnaces, etc.; the cost of plant, etc.—A. F. L., South Africa.—A.—Mr. C. E. Hall, Meersbrook Bank, Sheffield, makes the machinery you require.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

13th March, 1893.

5312 COMBINED GOVERNOR and TRIP-EXPANSION GEAR for STEAM or OTHER FLUID-PRESSURE ENGINES. W Cameron.

5343 NAIL-MAKING MACHINES. The Parkin Patent Nail Company Limited and G H Parkin.

5344 MACHINES for FORMING or MAKING IRONS for the SOLES and HEELS of CLOGS and BOOTS and SHOES. The Parkin Patent Nail Company Limited and G H Parkin.

5345 ADAPTING LEAD PENCILS for MEASURING RULES and SCALES.* G Pawson. (*W Douslin*, South Africa.)

5352 CENTRIFUGAL TURBINE SCREW PROPELLER. J Marshall.

5353 METALLIC ALLOYS or COMPOUNDS. R Howarth.

5355 RENDERING the SPARKING of COMMUTATORS, SWITCHES, and FUSES HARMLESS in EXPLOSIVE ATMOSPHERES. G Rolf and W C Mountain.

5362 INSTRUMENTS for ASSISTING DRAWING in PERSPECTIVE. S Venables.

5363 FURNACE SHELLS, FLUES, and MECHANICAL STOKING APPARATUS for STEAM BOILERS. G Sinclair.

5364 ROTARY PUMPS, BLOWERS, and EXHAUSTERS.* A Stewart.

5373 MACHINE VICES. G E Sherwin.

5375 MANUFACTURE or RESTORATION of FILTERING MEDIA. J Wetter. (*M Weinrich*, United States.)

5377 APPARATUS for AUTOMATICALLY BORING and SETTING OUT HOLES in the BOSSES of PULLEYS. H Crowther.

5379 Ship's Anchor.* C Bonger.
5384 Oil Gas. J Moeller.
5391 Lathes. H J Bamford.
5392 Metallic Tubes. B D V Cooper.
5394 Lubricators. T Greenwood and J W Whiteley.
5398 Galvanised Iron Plates. C G Tinn.
5399 Metallic Box-straps and Mechanism for Making the same. D Young. (*N Nilsson* and *K N Vanderbilt*, United States.)
5402 Fluid-pressure Engine also Applicable for use as a Pump. A H Crockford.
5406 Electric Railway Signalling. F P Schlosser.
5414 Hand Tool for use in Driving Bifurcated Rivets or Two-pronged Fastenings or Staples into Leather Belting.* S C Davidson.
5415 Refrigerating Apparatus. A J Boult. (*G Krauschitz*, Germany.)
5417 Miners' Safety Lamps. W Mills.
5418 Miners' Safety Lamps. W Mills.
5419 Electric Switches. H H Cass.
5423 Car Couplers. W L Wise. (*The American Safety Car Coupling Company*, United States.)
5424 Valve Gearing. A Radovanovic.
5430 Composition to be used for Hardening Steel. G Perrenoud.

14th March, 1893.

5438 Cranks. G H Hammond.
5439 Column to Maintain Upward Air Current. W Wagstaffe.
5447 Submarine Boat.* J R Haydon.
5456 Corrugated Cylinders for Heat Engines. J Trewhella.
5459 Valve for Rock Drills. W Jones.
5460 Valves and Taps Applicable for Steam, Water, and other Fluids. A Haigh.
5462 Packing of Steam Engine Pistons. W Shearer. (*W Hardie*, China.)
5467 Furnaces. J W Spencer.
5468 Gas Producers. J W Spencer.
5470 Railway Electric Fog Signals. H Sibery.
5477 Mechanism for Regulating the Admission of Steam in Steam Engines. W C Wilson.
5479 Sight-feed Lubricators.* A Welsh.
5486 Commutators for Dynamo-electric Machines.* A W Meston.
5488 Braced Metallic Girders.* F Prasil.
5490 Furnace Bar.* R Moffitt.
5492 Pressing and Bundling of Shearings or Scraps of Metal. D Grey.
5493 Centrifugal Machines for Separating Liquids. A J Boult. (*F Ludloff*, Germany.)
5495 Electro-deposition of Metals. W P Thompson. (*F L Pope*, United States.)
5496 Nautical Signals.* G O Perry and J R McGregor.
5502 Apparatus for Riddling, Sifting, Mixing, Washing, or Fettling Earth, Small Castings, etc. R J Lowry.
5505 Apparatus for Moulding the Bodies of Electric Switches, Bell Pushes, Ceiling Roses, etc., in China and Earthenware. H Watkin.
5506 Tag-making Machines.* W M Little.
5512 Machines for Bending Metal Tubes.* R Haddan. (*A Stirling*, United States.)
5514 Air Compressors.* C F Fogg.
5524 Railway Danger Signals.* A W Berne and W H Walsh.
5526 Tubular Boilers. J F Redman.
5531 Actuating Level-crossing Gates on Railways. L B Stevens.
5533 Apparatus for Moving and Turning Ingots whilst Passing through Rolling Mills. C Wawn.
5534 Rotary Gas or Oil Engine. J S Walch.
5538 Wood Screws.* H H Lake. (*M Herzberg* and *T L Norman*, United States.)
5545 Heating of Furnaces. E B Parnell.

15th March, 1893.

5550 New Motive Power. W W Crisp.
5551 Automatic Saw-sharpening Machine. R H and J F Shaw.
5552 "The Triplet" Railway Metal Coupling. H H Atkinson.
5556 Stuffing Box and like Packings. J R Green.
5558 Signalling or Communicating on Trains. A Shiels.
5561 Speed Governing Apparatus. S Dawson.
5562 Working Switch Points of Railways. H Williams.
5564 Lamps for Blistering, Soldering, and Brazing. A B McIlvride.
5568 Steel and Ingot Iron. T Twynam.
5570 Suspending Shackles or Cheeks. C H Bartlett.
5575 Automatic Apparatus for Indicating and Recording at a Distance Changes of Level of Water in Reservoirs, etc. J Barr and W McWhirter.
5590 Ball Cocks. F Breeden.
5591 Metal Tubes. E W Cooper.
5592 Sockets or Straps employed with Lead and other Piping. T Claughton.
5594 Arrangements for Working Railway Signals Electrically. I A Timmis.
5595 Device for Locking or Securing Nuts to Bolts. G Tabrar.
5599 Windmill System. D M Reid.
5605 Separation of Matter held in Suspension in Fluids. J Higginbottom.
5606 Anchors. H Charlton.
5618 Flexible Tubing. S O Cowper-Coles.
5631 Process for Preventing the Deposit of Incrustation on the Walls of Steam Boilers. F Dannert.
5632 Process for the Manufacture of Metal Partaking of the Nature of Steel. W Gilchrist and W Cryer.

16th March, 1893.

5636 Rolling Metal Plates and Cylinders. G Sinclair.
5638 Multiple Change-over Mechanism for Electric Arc Lamps. W J Davy.
5639 Multiple Telegraphy. J McCraith.
5647 Manufacture of Gas. J H R Dinsmore.
5648 Gas Hydraulic Mains. J H R Dinsmore.
5649 Apparatus for Opening and Shutting Gates.* R W Pound.
5650 Screw Propellers. J B Murray.
5651 Furnaces for Melting Glass, Puddling Iron, etc. C and C Bateson.
5652 Switches in connection with Electricity. J R Kay.
5653 Tram Rails. J Robinson.
5655 Electric Arc Lamps. C Richardson and E G Herbert.
5660 Adjustable Pipe Wrenches and Spanners.* R P Richards.
5670 Rotary Motors. R Armstrong.
5673 Pumps. R Thompson.
5681 Refining Engines used in the Manufacture of Paper. D Pearson.
5684 Portable Electric Primary Batteries, in their Application to Miners' Lamps. M P Tuckerman and A D Mackenzie.
5696 Heat-regulating Apparatus. B P Stockman and G P Doyle.
5697 Apparatus for Regulating Temperature.* J E Watts.
5701 Coating of Articles with Metallic Alloys by Electro-deposition. S O Cowper-Coles.
5708 Ball Valves. J T Garratt.
5709 Cores of Armatures for Dynamos, Magneto Machines, etc.* H F Jodel.
5710 Artificial Fuel for use in Ore-smelting Furnaces. R F Strong and A Gordon.

17th March, 1893.

5725 Rock Drill Carriages. M H Larmuth and R B Howarth.
5731 Gas Motor Engines. J Dougill.
5732 Apparatus or Machines for Cutting or Shearing Metals. H H Summers.
5733 Arrangement for Reading the Deflections of Reflecting Instruments. W Thomson. (Baron Kelvin.)
5739 Chain Makers' Cranes. A S Ross and W J Marshall.
5745 Apparatus for Cleaning the Rails of Street Tramways.* C T Bischoff.
5747 Apparatus for Blowing, Exhausting, and Pumping. F H Stacey and H Wilkinson.
5761 Rotary Motor. C Karpa and E Lange.
5763 The use of Oil and Water for Internal Lubrication and Cooling in Air and Gas Compressing Pumps. G E Bellis and A Morcom.
5771 Apparatus for Electric Lighting.* P Scharf.
5772 Filtering Apparatus. J Douglas.
5773 Multiple-expansion Engines.* H E Newton. (*C C Worthington*, United States.)
5774 Cleaning or Scraping of Tubes. A J Boult. (*C Knauss*, Belgium.)
5781 Smoke-consuming Apparatus for Steam Generators. A J Boult. (*J T Ellis*, Canada.)
5782 Telegraph Poles. T G Marsh.
5791 Apparatus for Feeding Plates or Bars to Punching and Shearing Machines. G B Hunter.
5795 High-pressure Taps. M A Brookes.
5797 Adjustable Hopper. E Dale.
5806 Apparatus for Charging and Drawing Gas Retorts.* J West.
5807 Railway Couplings. A G Vogt.
5812 Railway Car Couplings. R Hughes.

18th March, 1893.

5818 Band-sawing Machines. J and D Sagar.
5819 Screw Propellers. H Shield and D J Howells.
5821 Automatic Fog Signals for use on Railways. L Summerfield.
5830 Automatic Prepayment Gas Meter. W Alexander and W E Thompson.
5832 Paper-folding Machines. M Smith.
5833 Machinery for Rolling Wire Rods and Hoops.* J S Taylor.
5834 Band or Rope Driving of Machinery. W Kenyon and others.
5835 Automatic Brakes for Pulley Blocks and Hoists.* R Priest and W Morrall.
5847 Freezing or Refrigerating Apparatus. C Sachs.
5853 Anti-rattler for Thill Couplings on Carriages. E H Watrous.
5855 Apparatus connected with Softening and Purifying Water. C H Fitzmaurice.
5862 Cask-making Machines. A Ransome.
5864 Joiner's Concave and Convex Smoothing and Rebating Plane. A Gilbert.
5868 Aerial Machines. H F Phillips.
5869 Locking Nuts upon their Bolts or Studs. W Shears.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to Sir H. Reader Lack, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

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FRIDAY, APRIL 7TH, 1893.

A 500H.P. Electric Locomotive.

SOME time ago we referred to the proposed construction of an electric locomotive on a system devised by M. Heilmann, and the principle of which was first brought under public notice at a meeting of the Société Industrielle de Mulhouse in 1890. This society has just been presented with details of that system as now modified, and on the basis of which a locomotive is being constructed for experimental working. It will doubtless be remembered that the locomotive is to be a locomotive in the fullest sense of the word—one which will be capable of hauling a number of passenger coaches on an ordinary railway. In this respect it will differ from all existing electric locomotives, the most powerful of which does not do more than one-fifth of the work that a steam locomotive is generally called upon to perform. M. Heilmann's system may be roughly termed an electric-power station placed on wheels. His original idea was to use polyphase motors, and to put one motor not only on each axle of the locomotive, but also on each axle of the train. It was, however, found, owing to reasons into which it will be unnecessary to enter, that it would be unadvisable to adopt that type of motor, and M. Heilmann modified his method in so far as to decide upon the construction of a locomotive only, having a motor arranged on each axle, and capable of drawing an ordinary train, as does a steam locomotive. It is, therefore, one of this type which is now being built. The locomotive, as described by M. Heilmann, is arranged on two double-bogie trucks, and carries boiler, engine, generator, and exciter. It is intended to replace a locomotive of 500H.P., the total weight being 42 tons. The boiler is of the Lenz and the engine of the Brown type. The electric generator gives 1025 ampères at 400 volts when driven at 300 revolutions, and an exciting dynamo of 20H.P., actuated by a separate motor, will be used for the lighting of the train. There are eight motors, one arranged on each axle. It is doubtless owing to its ready applicability to existing lines that the French State Railway administration has consented to allow experiments to be conducted with this locomotive on one of the State railways. The use of a self-contained electric locomotive of this type seems at first sight to be rather an uneconomical method of traction; whether it will actually be so will be shown by the tests shortly to be made.

New Steel Plant.

A VERY powerful and complete steel plant has just been installed at the Parkhead forge. The cogging mill, said to be the largest and most complete in the kingdom, is provided with a pair of 42in. cylinder engines, driving a pair of 38ft. rolls weighing 14 tons each, a small pair of 6in. cylinder engines working the screw, to raise or lower the top roll as occasion requires. In connection four 25-ton Siemens-Martin smelting furnaces have been put down. The plate mill has a pair of 46in. cylinder engines, driving a pair of 32in. diameter rolls 10ft. 6in. wide, weighing 15 tons each, with a small pair of 6in. engines on the housing to work the screw, so as to raise or lower the rolls at will. These rolls have on each side a travelling table or platform, composed of geared rollers—the one side travelling independently of the other—extending to the back and front of another pair of hard rolls. A small pair of engines put the platform or rollers in motion as opportunity requires. The crane at the vertical furnaces takes the slab from the furnace, and lays it direct on the rollers in front of the rolls. These are set in motion, and the slab is pass by pass reduced to its required thickness until it is run on the mill floor a finished plate, to be sheared according to specification. This mill is now capable of turning out over 100 tons of finished plates every 12 hours, from ⅜in. upwards in thickness, and of all sizes and dimensions up to 12 tons in weight.

Lighting Towns from Balloons.

AN extraordinary scheme for the illumination of towns is suggested by a San Francisco man, who proposes to accomplish this by suspending arc lamps from captive balloons. According to his description the balloon would be made of aluminium and in the shape of a cigar, pointed at both ends, 40ft. long and 15ft. in diameter at its widest point, and containing sufficient gas to sustain it in the most severe weather. A cable containing the electric wires would hold the balloon at a sufficient elevation so that the light would be distributed to the best advantage over the area to be illuminated. The balloon would either have six arc lamps suspended from it, or be covered with incandescent lamps, each of which would be enclosed in a guard with reflector so as to concentrate the rays of light and throw them downwards. An appliance would be provided for hauling the balloon to the ground for trimming the lamps, or making repairs, or raising or lowering it so that the light might be advantageously distributed. It is claimed that the adoption of this system would considerably reduce the cost of the public lighting of large towns, and that it would dispense with the numerous overhead wires now used in the United States. The scheme is doubtless feasible, but it seems costly, and there would be a not inconsiderable waste of light.

A Novel Exhibit at Chicago.

VISITORS to Chicago will find a novel exhibit in the transportation building, where there is now being erected a length of about 100ft. of one of the new Atlantic steamers now being constructed at Philadelphia. This length will be the exact size of the ship itself, and the whole structure will represent the completed ship—indeed, in many cases the mouldings, pannelling, etc., will be taken from Chicago at the close of the Exhibition and be fitted into the hull when constructed on the Delaware. The part of the ship to be represented is that in which the saloon is situated forward of the machinery; and the construction will comprise the interior from keel to top deck. The two vessels now building will not be much larger than the British-built vessels lately taken over by the American Line, but it is anticipated that they will excel them slightly in speed. As about 21 or 21½ knots will be their speed, they are not likely to compete very keenly with the new vessels which are shortly to be added to the Cunard fleet.

Thermal Storage.

BEFORE the recent meeting of the National Electric Light Association, Prof. G. Forbes read a paper dealing with thermal storage for central electric-light stations, a subject which has attracted some attention in this country. The author pointed out that the engines at the Kensington station in the metropolis were always working at an economical load, 5lb. of coal being used per electrical horse-power per hour. On the other hand, tests of 24 hours' duration, made with the same plant, with all the boilers doing full work, showed that only 3½lb. of coal were required to perform the same duty. He therefore contended that if a system of storage of any kind could be adopted by which power was absorbed at times of light load and given off on occasions of heavy load, there would be a saving of 1½lb. of coal per horse-power per hour. After mentioning a method of water-power storage proposed by himself at the last meeting of the British Association, the Professor came to consider the system suggested by Mr. Druitt Halpin. Taken generally that arrangement is to put up boilers only of the average capacity, and to work them day and night. At times of light load the steam is carried through pipes into large iron reservoirs of cheap construction, and is used to heat up the water in those reservoirs to a high temperature and pressure. When the heavy demand comes on in the evening, steam is drawn from these reservoirs. The losses of heat from radiation from the reservoirs can with proper lagging be rendered very small. The author claimed for this method that it possessed the advantage of a pure supply of water to the boilers, as the pumps fed water into the reservoirs, and the impurities were precipitated where they could do no harm. Another advantage claimed was that priming in the boiler did not cause any inconvenience, as the steam was all supplied to the engines from the reservoirs. A comparison made by Mr. Halpin of a large station operated according to present practice, and of one with a method of thermal storage, showed on paper a distinct advantage in favour of the latter arrangement.

Improvements in Steam Diggers.

SOME improvements have lately been effected in the well-known Darby steam digger, by which the weight of the machine is reduced and a higher speed attained than heretofore. As now constructed, it consists of a portable engine of 8H.P., mounted on a pair of steering wheels at the front end and broad travelling wheels at the back end, carried under the footplate. To the rear of these wheels are four sets of steel digging tines, six to the set, driven from a four-throw crankshaft, so that no two sets of tines enter the ground at the same moment. Immediately beyond the movable digging tines is a bar carrying a set of 13 fixed tines and covering 14ft., that being the working width of the machine. As the digging tines throw up the earth the clods are projected against the fixed tines, and are thereby broken up. For travelling on the road the two outside sets of tines are taken off and the ends of the fixed tine bar folded back, so that the width of the machine over all is reduced to 9ft. The weight of this machine is 8 tons, and the tines are driven at an average speed of 134 strokes per minute, the working steam pressure being 120lb. per square inch. The digging apparatus is raised and lowered by means of a small independent steam cylinder, while the depth of cut is regulated by a screw and hand-wheel arrangement. The present form of digger is undoubtedly a marked advance on the previous machine.

On Machine Designing.

[CONTRIBUTED.]

INTRODUCTION.

THE literature on the art of machine designing is not very extensive. Books on "machine design" deal not so much with the method of designing as a whole—that is, originating, scheming out, and arranging machinery—as with the proportioning of machine details of *given* types. Indeed, considered as an exact science, the province of machine design is simply to show "how the parts of the machine are to be proportioned so as to resist deformation." This, however, is only one aspect of the much more comprehensive art of machine designing as understood and practised by the engineer.

Beyond a few fragmentary observations scattered here and there in the wide region of technical journalistic literature, not much information of the kind here referred to is available. For any fairly complete general treatment of the subject of the whole process—from the inception to the completion of a design—the aspirant after knowledge may seek in vain.

The present paper is a modest attempt to supply, in some measure, this deficiency. It constitutes a presentation of thoughts which have arisen during or been suggested by the actual work of designing; and sets forth the requirements and beauties of machines, as well as describes the mode in which mechanical contrivances are originated and worked out. It introduces no drawings, diagrams, computations or data, but deals only with the philosophy of this interesting department of scientific knowledge. It seeks, further, not merely to communicate facts—to impart information—but also to arouse an interest, to stimulate, to show how much there is in machinery to study, to learn and to enjoy.

On the importance of a knowledge of machine designing it is needless here to dwell. All who possess a rudimentary knowledge of mechanical engineering will realise that it is of the very highest import. For is it not to the end that he may become an efficient machine designer that the embryo engineer spends his days in gaining workshop experience; his evenings in studying the mechanical, mathematical, chemical and physical sciences; and the residue of his time in seeking to acquire such a knowledge of the principles and practice of art as will enable him, easily and correctly, to express or delineate those mechanical conceptions which result in the production of an original design?

At the outset of these remarks, it is to be clearly understood that drawing is not designing, and that a draughtsman (in the sense in which that term is here employed) is not necessarily a designer. It is very easy to make a drawing; very difficult to design a machine. A man may be a very competent draughtsman—he may be able to draw well; to represent very truthfully all the intricacies of a *given* object; to shade and colour in a superior manner; to produce the most beautiful and elaborately-finished drawings; in short, he may possess considerable artistic qualifications, and yet be wholly incapable of generating an original design—of conceiving, initiating, or planning a machine in all its completeness, harmony of movements, and just proportion of parts.

On the other hand, the skilful designer may not be a first-rate draughtsman; he may be "no great hand" at fine drawing, shading, and colouring; he may not, in brief, be much of an artist, but he *must* be

a practical engineer as well as a scientific man. He *must* thoroughly understand machinery, the properties of materials, the capabilities of workmen and tools, and, moreover, he must possess somewhat of that useful and valuable faculty, the power of originating or inventing.

But, although it is not absolutely necessary that the designer should be a first-rate draughtsman, it is nevertheless much better that he should be, for, *ceteris paribus*, such a man is more efficient, consequently he who aspires to become an able machine designer ought to use every endeavour—to seize every opportunity—early to acquire the desired artistic skill, especially the power of freehand sketching.

It has been said that the first essential of a good designer is *forethought*, the second *experiment*, and the third *courage*. These are of greater importance than beautiful drawings and indefinite calculation, useful as a certain amount of the latter undoubtedly is.

The subject will here be treated on in two main sections, namely :—

I. The requirements of a design.
II. The method of designing.

The qualities possessed by a well-designed machine are: Efficiency, elegance or neatness, and, as far as possible, simplicity and cheapness. A machine having these qualities does the work, looks well, and is not unnecessarily complex and expensive.

It is not always possible to make a machine which embodies *all* these somewhat conflicting requirements, so that a compromise has often to be effected. Cheapness, for example, has to be sacrificed for the sake of efficiency, and *vice versâ*: still, when engaged in designing, all these desired qualities have to be borne in mind.

THE CONDITIONS OF EFFICIENCY.

The primary aim of the designer may be said to be to plan a machine, or installation of machinery, which will perform a definite duty in the most direct and efficient manner permissible by the conditions of the case, and which will continue the performance of this duty for a maximum length of time with a minimum of expense for attendance, wear, and renewals. The conditions that conduce to this efficiency or excellence of working will now be considered in some detail.

(1.) SUFFICIENT POWER TO DO THE WORK REQUIRED.—This means—in a steam engine, for example—sufficient area of cylinder to develop the specified horse-power with a given or assumed boiler pressure and piston speed; in hydraulic machines it means sufficient area of ram and valve ports, with a given head or water pressure and rate of working; in hand-power gear it means the provision of suitable arrangements for a sufficient number of men to act in concert, at a convenient speed and pressure, on the handles; in reference to springs it means sufficient elasticity and range; and, generally, for all motive machinery, it means sufficient size and speed.

The size necessary for the performance of a given duty may, in general, be readily determined by calculation. Knowing also the number of foot-pounds of work that an average man is capable of performing, for a short time or for a longer period respectively, the number of men required for a certain duty, whether constant or intermittent, may likewise be computed with equal ease and certainty.

(2.) SUFFICIENT STRENGTH AND STIFFNESS OF THE PARTS TO RESIST THE FORCES ACTING ON THEM.—This implies—of steam and hydraulic cylinders and pipes—sufficient thickness and tenacity of material to resist the test pressure, as well as a fair allowance for the stresses set up during the cooling of castings, the displacement of cores, and foundry requirements generally. It means, further, of *shafts*, a sufficient diameter to resist a given or determined twisting moment without undue deflection with a material of known tenacity; of *gearing*, sufficient pitch and breadth of face of teeth to safely transmit the power at a given speed of rotation; of *columns* or pillars, a suitable form and area of section to resist the load to which they are subjected; of *rods*, a sufficient area of section to resist the pull; of *beams*, a suitable form and area of section to resist the maximum bending moment that comes upon them; of *pins*, sufficient section to resist the shearing force; and, generally, such a nature and disposition of material as will ensure that the internal stresses due to external loads will not exceed a predetermined safe limit.

The required area may usually be found by calculation; the most suitable material and form of section for each method of loading is already known by experiment and experience. That branch of engineering science which deals with this aspect of machine designing is usually known amongst engineers as "the strength of materials"; but according to Reuleaux, it constitutes the science of "machine design" as previously defined.

It is not *always* feasible, however, to compute the sizes of machine details. In many cases the forces acting are not known, and cannot be estimated with sufficient certainty. In others, even when the forces *are* known, the difficulty of applying exact calculation is so great that it has to be abandoned. Then the judgment, educated by practical experience, has to decide without the aid of mathematics. But such cases are gradually diminishing as the science of engineering, or the scientific knowledge of the designer, advances. It is also to be remembered that other considerations besides strength often, in part, determine dimensions.

Further, it is not seldom impossible to *calculate* the size which is necessary to obtain sufficient stiffness. It frequently happens that a detail which is abundantly large as to its capability to resist the disruptive force—that is, is quite strong enough,—is not by any means sufficiently stiff, but, on the contrary, possesses an inconvenient amount of "spring"; in other words, it is deficient in rigidity. In a lever-testing machine, for instance, where the multiplier is very great, and the least deflection objectionable, the levers may require to be designed with a factor of safety ten times greater than would suffice if strength to resist the bending moment were alone to be considered.

Nevertheless, calculations should always be performed wherever possible. To know that each detail has been made of ample strength, according to calculation, gives the designer a desirable feeling of certainty and security. It is better to omit calculation from choice than from necessity. In small work, the size is often regulated more by considerations of ease of manufacture, and the treatment likely to be received at the hands of workmen and tools, than by the actual stresses to which any particular detail will be finally subjected during use. Hence the utility and importance to the machine designer of a practical acquaintance with workshop methods and processes.

(To be continued.)

Machine Construction.

THE CONSTRUCTION OF MACHINE ELEMENTS.

(*Continued from page* 112.)

CHAPTER XI.

SIMPLE LEVERS.

§ 159.

JOURNALS FOR LEVERS.

IN machine design a simple lever, or rocker arm, is a lever arm which is mounted upon an axle or shaft, at the end, about which it moves, and carries a journal upon the other end. For the proportion of the journal see Chapter V. The forms which may be given to such journals are shown in Fig. 455, and are single overhung, double, or forked. The manner of securing the pin in the hub or lever is most important. The pin should not be driven in up to the shoulder on the taper, but sufficient space left to ensure that the fit is tight in the taper. This clearance is shown plainly in the figure. The same result may be attained by countersinking the collar into the hub on the lever. In the case of double overhanging pins, care should be taken that the load is equally divided between the two sides, so that the pressure upon each pin shall be equal to $\frac{1}{2}$ P. In the fork-ended lever the fit on both ends of the pin should be portions of the same cone.

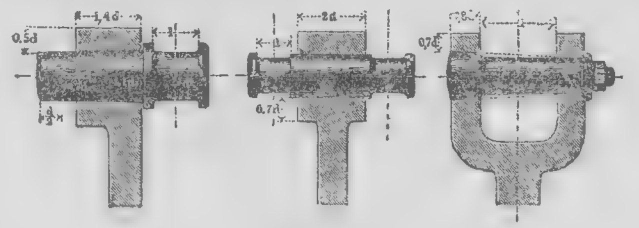


FIG. 455.

Example 1.—For P = 4400lb., we have from the table in § 90 for alternating pressure and wrought iron journal, the diameter $d = 0.027\sqrt{4400} = 1.8$in., and the length the same. For steel, we have $d = 0.024\sqrt{4400} = 1.6$in., and the length $l = 1.3 \times 1.6 = 2.08$in. For a forked lever, a wrought-iron pin with the same load, the diameter, according to (98) would be $d = 0.0185\sqrt{4400} = 1.2$in., and the length $l = 3.5 \times 1.2$in. $= 4.2$in.

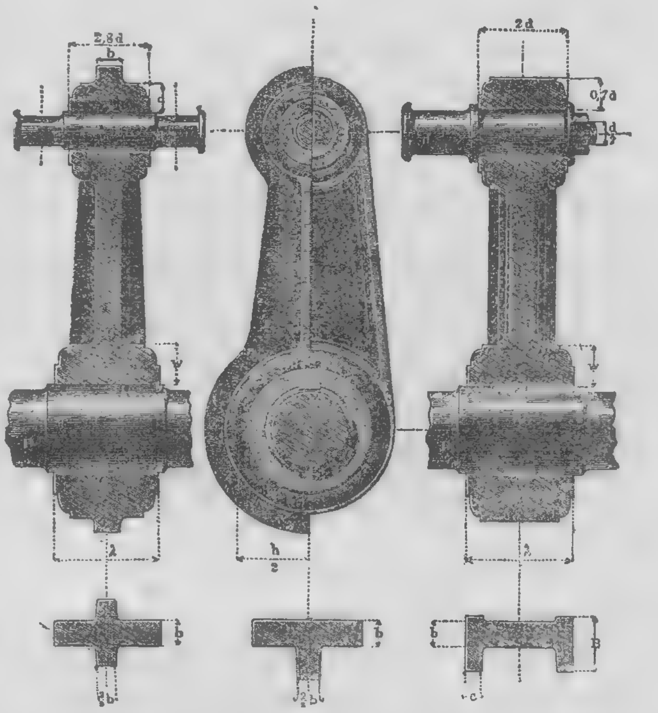
All levers are not subjected to alternating pressure, but have the pressure constantly in one direction—as, for example, the beams of single-acting pumping engines, etc. In such cases larger journals are needed.

Example 2.—A wrought-iron journal for a forked lever, under constant pressure of 4400lb., according to formula (98), should have a diameter $d = 0.0212\sqrt{4400} = 1.4$in., and length $l = 3d = 4.2$in. If the material had been cast iron, we should have had $d = 0.29\sqrt{4400} = 1.92$in., say 2in., and $l = 6$in. For steel we have $d = 0.0185\sqrt{4400} = 1.2$in., $l = 4\,d = 4.8$in.

§ 160.

CAST-IRON ROCK ARMS.

Rock arms may be either of cast or wrought iron. The hubs for wrought-iron arms are given in the preceding illustrations, and in Fig. 456 are given some proportions for the various parts of cast-iron arms. A fork-ended arm is shown below, among the walking beams; or if the fork hub is on the main axle, see the rules already given under Axles, Chapter VIII.



MACHINE CONSTRUCTION.—FIG. 456.

§ 161.

ROCK-ARM SHAFTS.

The axle upon which a rock arm works is usually subject both to bending and torsional stresses. The methods of calculation for all important cases are given in Chapters VIII. and IX. The case which occurs most commonly is the overhung rock arm at the end of a shaft, and this is here given a special examination.

If we have a, the distance between two planes normal to the axis, and passing through the middle of the pin and the middle of the bearing on the shaft (Fig. 457), there is an ideal bending moment with a lever arm R, acting upon the bearing of the shaft, for a load P on the pin equal to—

$$(Mb)i = Pa' = P\left(\frac{3}{8}a + \frac{5}{8}\sqrt{R^2 + a^2}\right) \quad \ldots (150)$$

See § 150.

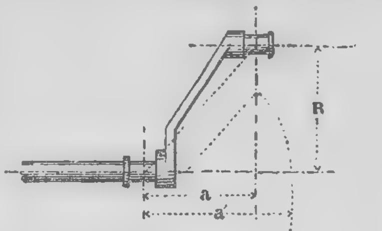


FIG. 457.

The lever arm a' is readily obtained graphically, as is shown in the illustration. For its numerical determination, we have :—

$$\left.\begin{array}{l} \text{If } R > a, \\ \quad a' = 0.625\,a + 0.6\,R; \\ \text{and if } R < a, \\ \quad a' = 0.957\,a + 0.25\,R \end{array}\right\} \quad \ldots\ldots\ldots (151)$$

The lever hub must be made strong enough when the shaft is only subject to torsion, or when it is also subject to bending. For wrought-iron shafts wrought-iron levers should be used, and for cast-iron shafts cast-iron levers.

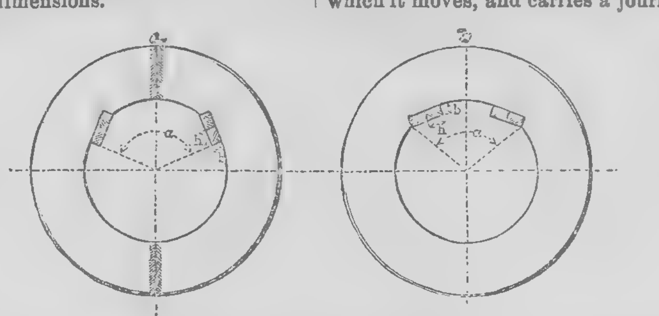
Let
w = thickness of metal of hub,
λ = length of hub,
D = the shaft diameter for the statical moment P R of a lever of the same resistance—see (133) and (134).

$$\left.\begin{array}{lcccc} \text{For} & \frac{w}{\lambda} & \frac{1}{2} & \frac{1}{25} & \frac{1}{3} \\ & \frac{w}{D} = & 0.45 & 0.42 & 0.40 \end{array}\right\} \quad \ldots\ldots\ldots (152)$$

If a lever is to be fitted to a shaft of greater diameter than D, we first determine the imaginary value of D, and insert it in (152). The same method is adopted if a cast-iron lever is to be used with a wrought-iron shaft, and *vice versâ*. The shape for cast-iron levers is given in Fig. 456.

Example 1.—If the lever of Example 1, § 159, is made of wrought iron, and is 24in. long, its statical moment P R = 24 × 440 = 105,600in.-lb. This gives, from (131) $D = 0.091\sqrt[3]{105{,}600} = 4.3$in.; and if we take $\frac{w}{\lambda} = \frac{1}{2}$, we have from (152), $w = 0.45 \times 4.3$in. $= 1.93$in. $\lambda = 1.93$in. $\times 2 = 3.86$in., say $3\frac{7}{8}$in.

The hub may also be calculated of such dimensions as to be strong enough to be forced on cold, and thus obtain sufficient friction to hold without the use of a key (see § 65, formula 66). The friction Q of the hub upon the shaft must then be $\geqq \left(\frac{PR}{\frac{1}{2}D'}\right)$ in which D′ is the diameter of the shaft at the point where the hub is fitted.



MACHINE CONSTRUCTION.—FIG. 458.

Example 2.—In the case of the same lever as the preceding example :—

$$D^1 = D, \text{ and } \frac{PR}{\frac{1}{2}D} = \frac{105{,}600}{2.15} = 49{,}116.$$

We may then take Q = 50,000, and let $l = \lambda = 3\frac{7}{8}$in., and $S_2 = 10{,}650$, and substituting in formula (66) we get :—

$$\frac{w}{D} = \frac{1}{2}\sqrt{\frac{\pi \times 4{\cdot}3 \times 3{\cdot}875 \times 0{\cdot}2 \times 10{,}650 + 50{,}000}{\pi \times 4{\cdot}3 \times 3{\cdot}875 \times 0{\cdot}2 \times 10{,}650 - 50{,}000}} - 1$$

$$\frac{w}{D} = \frac{1}{2}\sqrt{\frac{161{,}500}{61{,}500}} - 1 = \frac{1}{2} \times 0{\cdot}63 = 0{\cdot}31.$$

The key is used as an extra precaution for security.

A special method of keying, especially adapted for the hubs of levers and wheels, has been designed by engineer Peters. It consists of two parallel systems of keys, as shown in Fig. 458. The taper of the key is $\frac{1}{20}$. The arrangement shown at (*a*) is preferable, as it weakens the hub less than (*b*). The angle *a* may be taken = 135°, the thickness of keys $b = \frac{1}{16}$ D', and mean width $h = 2b$.

The form (*a*) is especially suited for hubs which are made in two parts.

Those hubs which are upon shafts subjected to bending are considered under the heading of Combined Levers, in Chapter XIII.

(To be continued.)

The Mannesmann Process of Seamless Tube Rolling.

(Continued from page 127.)

If a solid piece of metal be furnished with bevel ends, as shown in Fig. 7 at I., or if its thickness be reduced in one or more places, as shown in Fig. 8 at I., and such piece of metal be made to pass through the rollers in the manner set forth in the foregoing, it becomes tubular in the parts that were originally thick and remains solid in those that were reduced in size, as shown in Fig. 7 at II. and Fig. 8 at II. Pieces formed like Fig. 7 at II. may be used for railway shafts, as shown in Fig. 9. and those formed like Fig. 8 at II. may be cut in several places and used

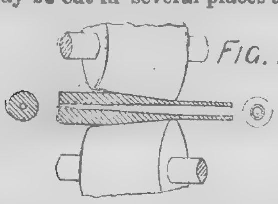


FIG. 10

for making grenades and for other purposes. In the process described, the direction in which the pressure takes place remains constant while the blank

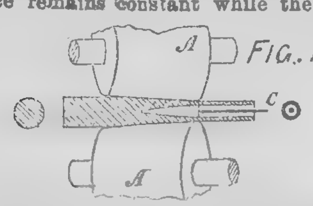


FIG. 11

rotates, or both may rotate, or oscillate, or perform any other motions either jointly or severally. In the same way the blank and rollers may work at the same speed or at different speeds, and in such cases the

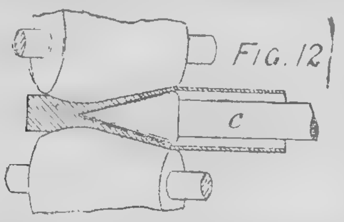
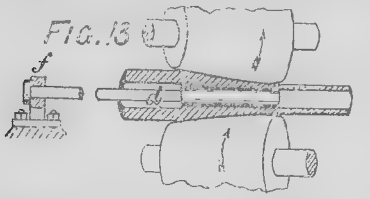


FIG. 12

surfaces of the rollers slide along the surfaces of the blank. By substituting working surfaces of a different nature for the roller surfaces, the entire process may be performed by a sliding instead of a rotatory motion of the working parts. In

FIG. 13



those cases in which the blank was already hollow at the outset, the hole may be enlarged by a proper adjustment of the position of the rollers while the process is

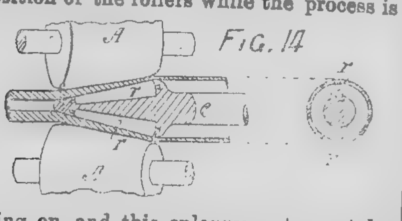


FIG. 14

going on, and this enlargement may take place although the diameter of the blank itself is being reduced, as shown in Fig. 10. By the adjustment referred to a centrifugal tendency may be imparted to the material by which the hole is enlarged. This tendency may be turned to account for the purpose of enabling a core, pool, or other appliance to force its way into the solid metal, such core or other appliance remaining either motionless or rotating, oscillating or moving in any other way, and being either hot or cold or being cooled by water, air, or gas, and the most suitable form of such core or other appliance being determined in accordance with the cone formed between the solid and the hollow portion of the blank while the progress of the operation is suspended. By means of the core, a greater amount of smoothness may be given to the hole produced or enlarged by the operation. A core C is shown in Fig. 11. By this core the blank is prevented from sloping in the direction of its axis, and eventually rotates over it in the form of a pipe. The diameter of the

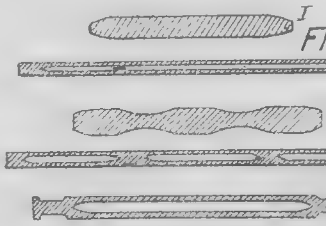


FIG. 7 FIG. 8 FIG. 9

finished pipe may be equal to, larger or smaller than that of the original blank; but in practice the adjustment is to be made in such a way as to add to the tendency of the hole to enlarge itself. To this end the core or tool is made thicker at one end, as shown in Fig. 12.

As the hole grows larger, the centripetal tendency of the core increases, or, in other words, its axis seeks to identify itself with the axis of rotation of the blank, even though the core had not been originally inserted in the middle of the blank, and even though no hole could be formed without a core. If in the case of a long, solid blank the core or tool be inserted first from one end and then from the other, in both instances to half the length of the blank, the two holes formed will meet accurately in the middle and become concentric, although the tool may originally have been inserted eccentrically; and thus long pipes may be made, of which the sides have a uniform thickness.

The working of the core or tool may be assisted, and its wear and tear partly

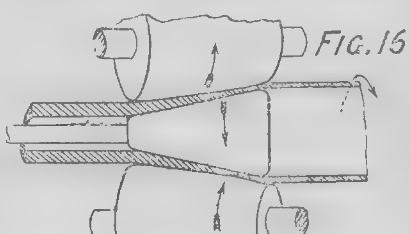


FIG. 16

counteracted, by the centrifugal tendency of the material, owing to which a hole spontaneously enlarges itself, even when no core, tool, or "thorn" is used. In the arrangement shown in Fig. 13, the pipe, while being rolled, slides over the core *d*, which is fixed within the bearing *f* in such a way that it may revolve around its own axis. The body of the core may be cylindrical or conical, or may be given any other suitable shape. In the arrangements shown in Figs. 11 and 12, the core works by direct pressure only, whilst in Fig. 14 the core *e* is furnished with friction rollers *r r* which tend to increase both the internal and the external diameter of the pipe. These friction rollers ought always to be opposite to the rollers A A, and consequently the core ought not to rotate in this arrangement. By varying the tendency to the formation or enlargement of the hole, the pressure with which the material moves or bears on the core may likewise be varied, and by this method a smooth and even a polished surface may be given to the interior of the pipe.

If the thickness of the side of the pipe at its various stages of manufacture be not very great in proportion to the internal or external diameter of the pipe, the round of the core takes its share in the drawing out, whereas in the case of the sides being thicker in proportion, the function of the core is to give greater smoothness to the inside of the pipe and to secure the perfect rotundity both of the inside and the outside of the finished pipe. But if the side be very thin, the round of the core may tend to stretch the pipe in the direction of the circumference; and if towards the egress of the pipe the distance of the rollers from one another become greater and the core thicker, an enlargement of the external dimensions of the pipe may be readily achieved, provided the proportions be appropriately chosen. As the outside diameter increases the diameter of the hole must increase in proportion, so that the sectional area of the pipe at the egress is never greater, but mostly equal to or less than what it is at the ingress, provided no special arrangements are made for varying the sectional area in the longitudinal direction of the pipe. In the arrangements Figs. 12 and 15, the core acts by pressure, and in Fig. 16 by tension, and the best plan is to let it rotate along with the pipe itself. When the core acts by pressure the pipe in its finished state moves on to the core, and when the core acts by tension the pipe slips automatically away from it. The shape of the core depends essentially on the cone formed by the inclination of the rollers to one another, on the minimum dimension

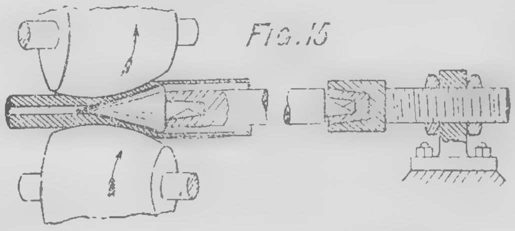


FIG. 15

of the blank, and on the desired thickness of the sides of the pipe, and the best plan is to find it out by experience for the various dimensions and materials.

In the screw and nut arrangement shown in Fig. 15, the thickness of the sides of the pipe may be varied by adjusting the position of the conic core, and it becomes easy

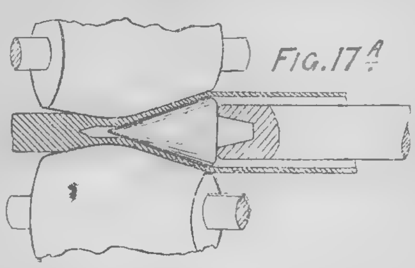


FIG. 17A

in such a case to find out the most advantageous position of the core. The correlative position of the rollers may likewise be adjusted so as to secure the conicity most suitable for adapting the rollers to any given core. The adjustment of the core in the direction of its axis and the adjustment of the position of the rollers towards one another may be effected between the hours of work, or even while the work is going on, by means of any of the well-known mechanical or hydraulic appliances. The adjustment of the core in the direction of its axis is equally useful for bringing a thicker portion of the core between the rollers when required.

If the shape shown in Figs. 12, 14, 15, 16, 17A and 17B be given to the rollers, the blank may be reduced in thickness by

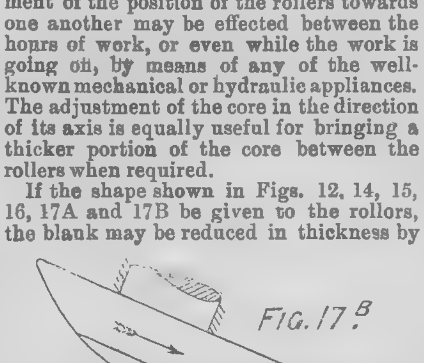


FIG. 17B

the first part of the rollers, provided its initial thickness was less than the least distance of the rollers from each other; and by the second part of the rollers its external dimension may be enlarged again. In this case, the least distance of the rollers from one another is at a point between the ingress and the egress of the blank. If the front part of the blank has once been rolled into a hollow or tubular form, as shown in Fig. 12, 17A and 17B, or if such a tension has been induced therein as to admit of a core being inserted, as in Fig. 12, pipes with thinner sides may be made out of the solid blank at one passage through the rollers, either with reduced, equal, or increased external dimensions. In the arrangements Fig. 17A and 17B, the core has no other duty but that of enlarging the hole, the front of the rollers having already given a tubular form to the blank. In Fig. 12, on the contrary, the core also aids in forming the hole and in making its surface more smooth and uniform at the initial stage.

(To be continued.)

The Institution of Naval Architects.

(Concluded from page 125.)

CHANGES IN THE FORM OF BOILERS.

Mr. T. J. Milton presented a paper, "Notes on Some Alterations of Form to which Boilers are subject when under Working Conditions." The author referred particularly to alterations of form which resulted from variations of pressure alone, the most important being the variations of the transverse dimensions of the combustion chambers and the alteration of shape of the cylindrical shell. By means of illustrations and a series of tables he showed that the greatest alteration which took place was in the horizontal width of the combustion chambers, at about the level of the centre of the wing furnaces. In a section of a boiler at that part the wing chamber plates at about this level were parts of cylindrical surfaces, and if there were no stays fixed to them they would retain their form when the boiler was subjected to pressure. Evidently, then, if, in addition to the pressure, they had forces acting on them produced by the pull of the stays, they must alter form, yielding in the direction of the pull, the case being similar to that of the shell plating acted on by the pull of the side stays. If any yielding took place in this direction, the side plating of the centre chamber must be equally distorted, and in some cases the narrowing of the centre chamber produced by this distortion was nearly a quarter of an inch at the working pressure, and as much as half-an-inch at the testing pressure. The yielding of the wing chamber side plating was, of course, of equal amount to that of the plating of the centre chamber; but as it was outwards at this side, while the plating at the other side yielded inwards, the width of the wing chambers at this part was not so much altered, and the straining action was therefore somewhat masked.

It was also to be noticed that in the side chambers, the plating being continuous at this part with the furnaces, the deformation referred to would take place without producing severe local stresses; but in the centre chamber at this level the tube-plates prevented any yielding of the side plating adjacent to them, and the deformation, being of the extent above mentioned at the centre, and nearly as much at the end stays, but practically nothing at the tube-plate ends, must put a severe local strain on the plates, especially if the staying was close to the tube-plate flange. In two-furnace boilers, and in double-ended boilers with two furnaces at each end, the deformation of the shell was also found to take place, and in consequence the combustion chambers were also deformed; but there being no corresponding part to the narrowest part of the centre combustion chamber of three-furnace boilers, the maximum deflection was less. The boilers mentioned were constructed in the most common way.

THE RECORDING OF STEAMER VIBRATIONS.

"An Apparatus for Measuring and Registering the Vibrations of Steamers" was described in a paper by Mr. Otto Schlick. He pointed out that in order to continue researches on this subject with good results, it was necessary to procure an instrument which would record the movements of the vibrations in a trustworthy form, as a diagram. After numerous experiments, he had succeeded in producing an instrument which, it was said, met the requirements in the most satisfactory manner. The apparatus, to which the name Pallograph had been given, was founded on the principle of so hanging a weight that, in consequence of its inertia, it took no part in a given direction in the tremblings and oscillations of the point to which it was suspended. As it appeared necessary for the purpose of the experiments to take cognisance of the vibrations in both a vertical and a horizontal direction, the apparatus possessed two weights—one which could only move in a vertical, and another which could only move in a horizontal direction. The author then described the apparatus, which has already

done good work, and which it would be difficult to explain without illustrations.

THE REPAIRING OF FRACTURES.

In a paper entitled "A Method for the Immediate Temporary Repairs of any Form or Size of Fractures that may be made in the Iron Plates of Ships," Captain J. Kiddle, R.N., described a system of effecting repairs of ships of the Navy or mercantile marine in case of fractures by shot, shell, collision, or by stranding. The system consists in the use of what are termed self-securing elastic wedges adapted to yield to any irregular form of the edge of a fracture. The case of the wedge is made of two parts of canvas. The author goes on to say that the form of the wedge conforms with the iron plate on the top; through this plate an iron pin passes to the bottom of the wedge and goes through a second iron plate which is of the width for the security of the bottom of the wedge. The case of the wedge is thrummed with the strands of small rope, and the strands of the thrums are teased out, this forming a soft yielding surface. If necessary, steel plates may be put between the two parts of canvas of the wedge to strengthen it. The wedges are stuffed with tow or other suitable substance. Wedges on this system have been made in a variety of sizes and forms. If the fracture happens to be beyond the limited size of the wedges, the author has introduced a method of shering the fracture so as to bring the limited diameter of the wedges available for the repairs. The repairs are effected by the use of a stage put over the ship's side, or if the fracture is under the water line, the men on the stages put on diving dresses and deal with the fractures.

THE STABILITY OF SHIPS.

A paper "On Approximate Curves of Stability," by Mr. W. Hök, was afterwards read. The repeated occurrences of ships failing to attain the ideal in regard to stability, led one to the conclusion that the teachings of scientific men concerning stability were in practice either partly ignored, or in some way ineffectively applied. There were printed in the Transactions of the Institution methods by which the complete statical stability of a ship could be obtained in a few days, and the complete dynamical stability within one day; but those methods were not sufficiently short to enable the designer to use them at all in connection with his preliminary work. He (the designer), therefore, as far as the author was aware, confined himself to investigate the initial stability, and left the complete investigation to be made during or after construction. This was, under the circumstances, the only practicable way; but must it not be admitted that the benefit that accrued from a complete investigation was almost entirely lost? The ship might turn out a failure, and yet no subsequent calculation could ever obviate it. It was therefore necessary that the present irrational order of things — viz., letting investigation succeed construction, instead of preceding it—should be reversed. What was then required was a method of investigation, approximate or exact, but of extreme rapidity and effectiveness, so as to enable the designer to bring its teaching to bear upon his work, and the reversal of the present practice would be assured. The author then showed, by a system he had worked out, how to obtain the curve of stability by an approximate method for all kinds of ships, and also the principles on which it was based. The groundwork was founded on direct calculation, which seemed to be the most hopeful way of attacking an intricate problem, and the method of application was based on true scientific principles. To build up a system of ratio curves embracing the different types of ships constructed in individual yards was, no doubt, a laborious task, but it would enable the builder to again utilise the enormous amount of stability work that had by this time accumulated in his offices. It could not be disputed that when completed it formed a valuable collection of data, by which any question of stability could be solved within a reasonable time, and by which, if the information it contained was brought to bear on the designing, and the lessons it taught acted on, the selection of dimensions and form of ships might in the future be more felicitous than it had sometimes been in the past.

RUNNING TRIPLE AS COMPOUND ENGINES.

"Some Experiments with the Engines of the s.s. 'Iveagh'" was the title of a paper by Mr. J. Inglis. This steamer is of 600 tons gross, built for the cross-channel traffic between Newry and Liverpool. She is fitted with three-cylinder engines, 1000I.H.P., of the inverted type. It was on the occasion of the trial trip that it was decided to make the experiment about to be described.

On the first day's trial the intermediate slide valve was removed, the connecting rod detached from the crankpin, the piston supported at the top of the cylinder, and the engines run with two cylinders only, as a compound engine. A water meter was placed on the suction side of the feed pump, and the whole of the feed water passed through it. The engines were run at a speed as nearly uniform as possible for four consecutive hours, and during this time the consumption of coal, the feed water, pressure, revolutions, etc., were carefully observed. On the following day the intermediate engine was reconnected, and, after a progressive trial at the measured mile, another four hours' run was made at as nearly as possible the same boiler pressure (125lb.) as was maintained on the first day, the observations being continued as before.

The results showed that with only 2lb. more boiler pressure, three additional revolutions, 80I.H.P., and 0·24 knot more speed were obtained, while the consumption of coal fell from 134lb. per nautical mile to 94lb., a difference of nearly 30 per cent.

The feed water, as shown by meter, was 10·36lb. per lb. of coal on the first day's trial, and 10·38lb. on the second; the efficiency of the boiler apparently remained constant. The saving was therefore entirely within the engines.

The arrangement of cylinders, cut-offs, etc, was not favourable to the compound engine. If the cut-off in the low-pressure cylinder could have been altered to about 15½in., instead of 22⅝in. (the actual cut-off), and the diameter of the high-pressure cylinder increased from 18in. to 21½in., the consumption with the two-cylinder engine would probably not have exceeded 1⅞lb. per indicated horse-power per hour in similar circumstances.

The coal used was from the Slamannan district. Its evaporative power, as shown by Wright's calorimeter, was 11·78lb. water per lb. of coal. The feed water as used weighed 9½lb. per gallon; no doubt it held air in suspension.

A paper by Mr. H. A. B. Cole, "On Working Triple-expansion Engines as Compound," was next read. The author mentioned that this was an expedient only to be resorted to when an engine had to be worked very much below the normal power. A line of steamers under his superintendence, after proceeding to the Cape at about 10½ knots, travelled to India and became ordinary trading boats, with the result that they had twice as much power in them as was required for the second portion of their voyage, the speed then being from 8½ to 9 knots. It was decided to work the engines compound, the method adopted being to disuse the low-pressure engine by taking out its slide valve and piston ring. As the pumps were all worked off that engine, it could not be disconnected altogether by hanging the connecting rod. The author regretted that his experience of the subject was as yet too short to enable a statement to be made of what increased efficiency, if any, was actually obtained in practice by working triples in that manner when they were only required to develop a small portion of their power. There was, however, the saving in the sense that practically all wear and tear of the low-pressure engine was avoided, the only load upon any part of it being due to the pumps.

MULTI-CYLINDER ENGINES.

The concluding paper was by Mr. F. Edwards, on "The Cyclogram, or Clock-face Diagram of the Sequence of Pressures in Multi-cylinder Steam Engines." He pointed out that in this type of engine it was desirable to know what was the fall of pressure between an exhausting cylinder and the cylinder receiving the exhaust; and that it was also desirable to get at a glance an idea of the course of the steam, the time it was waiting in the receiver, and whether the steam from the bottom went to the upper side or to the underside of the next piston. Whether the object of that inquiry was the better understanding of the action of the steam or the determination of the validity of diagrams received as a set, the requisite comparison of simultaneous pressures could not be read directly from indicator diagrams. He had been shown at the Board of Trade Office the cyclogram, or clock-face diagram, which was a simple and effective way of exhibiting that information. In the cyclogram the simultaneous pressures in all the cylinders were represented on the same radial line, to the same scale, and the differences and the sequences of pressures were therefore directly readable. He exhibited a cyclogram which he had constructed.

On the conclusion of the reading of the papers an illuminated address, recording the regret of the members at his retirement from the office of president, was presented to the Earl of Ravensworth, who had acted in that capacity for fourteen years. This terminated the proceedings.

Leeds Association of Engineers.

At the last ordinary meeting, held in the Yorkshire College Engineering Lecture-room (the president, Mr. Robert Lupton, in the chair), Professor Goodman read a paper on "Steam-engine Economy." He showed the extent of the waste of energy during the transformation of heat into mechanical work, explaining the causes, tracing the successive steps by which to a large extent they had been eliminated, and comparing the crude contrivances of early inventors with the more perfect machinery of the present day. He said that James Watt, when he brought out the separate condenser and steam jacket, thought he had discovered an engine which would not waste a particle of steam; but such was not the case; and although Hornblower and Woolf effected another great improvement in very materially reducing the consumption of steam by expanding it to a certain point in one cylinder, and finishing off the expansion in a second, there were certain limits in the attainment of economy beyond which it was impossible to go, as the saving effected in one way would be lost in another. Professor Goodman discussed in detail the various methods for preventing loss by initial condensation, such as hot-air jackets, heating cylinders with gas, etc., and invited the members to the engine room, where they were shown, by means of a small glass cylinder attached to the college engine, the phenomenon of initial condensation and re-evaporation during expansion. The paper was illustrated by lantern diagrams and tables giving the result of actual experiments. A discussion followed, in which Messrs. Lupton, Towler, Drake, Jefferson, and Blackburn took part. A hearty vote of thanks was accorded to Professor Goodman, on the motion of Mr. Lupton, seconded by Mr. Charles Holgate.

The Institution of Civil Engineers.

At the ordinary meeting on Tuesday, the 28th ult. (Mr. Harrison Hayter, president, in the chair), a paper was read giving an account of the methods adopted in the construction of "The Foundations of the Two River Piers of the Tower Bridge," by G. E. W. Cruttwell, M. Inst. C.E.

Owing to the weight of the lofty towers supporting the suspension chains of the shore-spans, and the high-level footways over the opening span of the bridge, the dimensions of the foundations, with a load of 4 tons per superficial foot, worked out to 100ft. in width by 204½ft. from end to end of the cut-waters. This large area was excavated by sinking four caissons, each 28ft. square, on the north and south sides of each pier, with two triangular-shaped caissons at each cut-water. The 12 caissons of each pier were all spaced 2ft. 6in. apart, and enclosed between them a rectangular space, 34ft. by 124½ft., in the heart of the pier. This was not excavated until the permanent work forming the outer portion of the pier had been built continuously within the caissons, and in the narrow spaces between them, up to the level of a few feet above high-water. This method was cheaper and was attended with less risk than that of using larger caissons extending across the pier.

The caissons consisted of a single skin of wrought iron varying in thickness from ½in. at the bottom to ¼in. at the top. The skin was supported every three or four feet in height by pitch-pine frames, with diagonals of the same material across. The joints of the removable portions were made watertight with indiarubber. The bottom section of each caisson was erected on a temporary platform fixed a short distance above low-water. Two pairs of trussed beams were placed above the caisson, with their ends supported upon the staging on either side, and four 2¼in. rods passed between the beams, and were connected to the caisson near each corner. The rods were screwed at the top for several feet, and, by setting up the screws, the caisson was slightly lifted, whilst the platform was cleared away from beneath. The caisson was then lowered down on to the bed of the river, and the excavation was commenced. Divers and grab-machinery were employed at first; but, as the ground consisted of the London clay, it was only necessary to sink the caissons some few feet beneath the river bed, when the water could be pumped out of them, and the excavation continued in the dry.

The reliable nature of the clay rendered it possible to under-cut beneath and beyond the bottoms of the caissons, whereby a considerable saving was effected in contracting the limits of the caissons within the outside line of the foundations. The under-cutting was timbered with 1½in. poling boards, strutted back with timber props against the bottom of the foundations. By executing the under-cutting in sections, and quickly filling in the concrete as soon as the excavation of each section was completed, the danger that was liable to arise from any serious swelling of the clay was much diminished. After two adjoining caissons had been sunk and partially filled with concrete, the space between them was enclosed by driving piles in grooves specially provided at the corners of the caissons. This allowed the adjoining sides to be removed and the intervening space to be excavated and concreted up; thus converting the two caissons into one. By repeating the process, a continuous caisson surrounding the heart of the pier was obtained. Within this, the outer portion of the pier was built to a height of 4ft. above Trinity high-water, thus forming a cofferdam to exclude the tide from the inner portion of the work. When the latter had been pumped out and excavated, the inner sides of the caissons were taken out, and the heart of the pier was filled in. The whole work was bonded together by numerous dovetails in the concrete, and by toothings and rackings in the brick work.

The materials in the two piers, from foundation line up to a level of 4ft. above Trinity high-water (a height of 60ft.), consisted of 25,220 cubic yards of cement concrete, 22,400 cubic yards of brickwork in cement, and 3340 cubic yards of Cornish granite; making a total of 50,960 cubic yards. The cost of the same, including all subsidiary items, such as stagings, caissons and excavations, amounted to £111,122; so that the average cost of the construction was £2 3s. 7d. per cubic yard.

Shipbuilding Notes.

Messrs. Russell and Co. launched from their Greenock yard on the 29th ult. a steel sailing ship, to register about 1850 net, and to carry about 3200 tons deadweight. The dimensions are:—262ft. by 40ft. by 23ft.

On the 1st inst., Messrs. Lobnitz and Co. launched from their yard at Renfrew a screw steamer 231ft. long by 31ft. beam, for the United Steamship Company of Copenhagen. She will be fitted with triple-expansion engines by the builders.

On the 1st inst., there was launched by Messrs. Harland and Wolff, Belfast, a new steamer named "Sarmiento," built for the Pacific Steam Navigation Company. Her gross tonnage is 3580. The triple-expansion engines, which have an indicated horse-power of 1900, have been constructed by the builders.

On the 1st inst., Sir Raylton Dixon and Co. launched from their Cleveland Dockyard, Middlesbrough, a screw steam hopper, of special design, for the London and South-Western Railway Company, for use in connection with the improvements of docks, etc., at Southampton. She has a hopper capacity of over 500 tons of dredged materials. Her dimensions are:—Length, 152·6; beam, 25·1; depth, 10ft. Engines will be fitted by Messrs. Westgarth, English and Co., Middlesbrough.

The new Donaldson liner "Tritonia," built and engined by Messrs. D. and W. Henderson and Co., Partick, went her trial trip on the 31st ult., on the Firth of Clyde. The results were in every respect satisfactory, and with 3500 tons deadweight on board a mean speed of over 12 knots was obtained, which was in excess of the contract. The dimensions are as follow:—377ft. between perpendiculars; breadth moulded, 46ft.; depth moulded, 31ft.; and deadweight capacity, 5640 tons. The engines have cylinders 26, 42, and 20in. in diameter by 54in. stroke. The two boilers are fitted with Messrs. Howden's forced draft apparatus.

An important addition was made to the effective strength of the Royal Navy on the 30th ult., by the passing out of hand at Sheerness Dockyard of the new second-class cruiser "Brilliant." She has a length of 300ft., a breadth of 43ft. 8in., and a mean load draught of 17ft. 6in. At her eight hours' natural draught trial her engines registered a mean of 7522H.P., with an average speed of 19·2 knots. Her forced draught trial was equally satisfactory, the engines indicating 9180H.P., with a speed of 20·4 knots, the speed estimated being 19·75 knots. The horse-power contracted for was 7000 under natural draught and 9000 under forced draught. The "Brilliant" has been armed with two 6in., six 4·7in., and nine 32-pounder and six-pounder quick-firing guns. She has been built under the provisions of the Naval Defence Act, and her total cost, including guns, has been about £220,000.

Metal-cutting Tools.

(*Continued from page 128.*)

In shape the groove should be made deeper than that described for reamers, but in other respects it may be the same. Except in extremely large sizes the number of grooves should invariably be four. The relation of their width to that of the teeth may be equal, or considerably greater, but never less, as it will not only leave insufficient space for the free discharge of chips, but renders the surface of the teeth unnecessarily large. For hand taps the back ends of the teeth—*i.e.*, the left-hand side of groove—should never be rounded over, although it is not uncommonly done. The reason is that it tends to cause jamming of the chips, particularly in wrought iron or steel, when the tap is backed, and may seriously injure the thread in the work. The right-hand face of groove forming the cutting edge of the teeth should be always radial with axis of tap. If tangent forward, it gives an obtuse angle to the cutting edge, which impairs its cutting properties; and if backward, it weakens the teeth in withstanding the slight frictional strain of backing, and may cause them to break off at the points.

One of the most important operations, and one which is most often neglected or improperly done, is giving the required clearance to the teeth back of the edge. Notwithstanding the fact that it is to this more than to any other feature of taps and dies that their free cutting is due, it is not uncommon to find it altogether omitted. It is needless to say that no matter how carefully or correctly made the tools may be in other respects, it is impossible for them to cut freely without this clearance, and the consequence is a hard-working tap. In the manufactured tools the operation is performed by means of special facilities which are not available in an ordinary machine shop, and the substitute must be hand filing. As the angle of all the different forms of V-threads is 60°, the ordinary triangular saw-file, being of the same angle, is of the proper shape, and although the cut is not the best for the purpose, it may be—and generally is—used. While no exceptional degree of skill is required, it is necessary to exercise the greatest care in the operation, as a mere slip of the file may destroy the cut of the tooth, and a very few such slips will cause the tap to work badly, no matter how freely the large majority of the teeth may cut.

The clearance should be started comparatively close to the edge—say a distance of about one-fourth of pitch of the thread, and worked backward to the heel of the tooth. A very small amount of filing is necessary, starting at nothing and uniformly increasing until run out. If the clearance is made too great, while the tap will cut very freely it is liable to cut too large by hand, and in backing is apt to jam and chip the tooth points. While apparently a tedious operation, the work can be done in this way more rapidly than might be supposed, and with proper care the result is by no means uncertain. Machine taps being intended to run continuously through the hole do not need to be backed, and consequently such features as are necessary to provide for this in the case of the hand tap, may be omitted. The taps are made much longer in both the thread and shank, the diameter of the latter being a shade less than that of bottom of thread, to enable it to slip freely through the tapped hole. The taper should extend from the point of the tap to within 2 or 3 diameters from the end of the thread, the size of the point being slightly less than that of the hole capable of allowing of full thread. This, of course, is below the bottom of the teeth, and ensures its starting freely, even if the hole be slightly under size. For this continuous cutting it is necessary to have an ample supply of a proper lubricant, or the result may be a broken or stripped tap, as well as spoiled work. Menhaden, or some similar fish oil, may be considered as best for the purpose, and as all improved tapping machines and bolt cutters are provided with pumps and tanks, a constant stream of oil may be kept flowing on the tap or bolt with very small expenditure of the lubricant.

Hand taps are generally made three, and sometimes four, to the set for each size, though the number actually required need not exceed two. The first, or taper tap, has full thread the entire length, and is cut taper from the size at the point, somewhat below that of the tap drill, to standard size at the top. It is intended to start the thread in the hole, to facilitate the entering of the starting tap, but its use may be considered as entirely superfluous, and in fact is usually dispensed with. The other three taps are cut standard as to shape and size of thread, the difference being in the finishing of the points. The starting tap tapers for about one-half its length from below the bottom of the thread at the point. For through holes it may be used alone by running it entirely through, after the manner of the machine tap. Where the hole is drilled only to a certain depth in the solid metal, the tap should be run in until the point touches bottom, and it is then followed by the plug tap, which has a much quicker and shorter taper, and will therefore carry the full thread to a correspondingly greater depth in the hole.

Where the character of the work does not prevent it, the hole is generally drilled deeper than the required length of the full thread to allow for the tapered end of the plug-tap; but in case this is not possible, the use of the last or bottoming tap is necessary. This has a full thread to the extreme point, the only taper allowed being about a 45° chamfer, to strengthen the leading teeth, which, of course, are required to do all the cutting. Owing to this fact the tap must be used with extreme care, or the teeth will be unable to bear the strain. Of course, it is impossible to apply the continuous motion which is proper in the use of the other three taps; it must be worked back and forth when nearing the bottom, and on no account must it be forced after the resistance indicates that it has reached the full cut, or brings up on bottom. The tap has one advantage peculiar to it, in that when the leading teeth become broken or damaged by the exceptionally hard usage to which they are subjected, the end may be ground square off on the grindstone until the next perfect teeth are reached, and the latter carefully bevelled from the points back to give clearance.

Most modern hand taps have the shanks turned down to the size of the bottom of the thread, which is much the best form, as it enables the tools to be run through all through holes instead of backing them out. Where the diameter is thus reduced, the square head is rendered so much smaller as to necessitate it being very carefully squared and accurately fitted to the wrench, as otherwise it will soon become so worn and rounded as to cause slipping and probable breakage of the tap. For special work, the temper of hand taps may be made to suit the nature of the material for which they are intended; but for general shop use it should not be harder than dark straw colour, nor softer than a full brown.

The hardening, like that of the reamer, requires the greatest care and skill to avoid springing or breakage. It should be done in the manner previously described, as also the tempering. In the latter process, the danger of bad results is even more imminent than in case of the reamer, as the delicate points of the teeth will almost inevitably be drawn too low, unless the heating be very slow, to allow of perfect equalisation. Whenever obtainable, the material used for making taps should be a quality of steel specially designed for the purpose, as it possesses great strength to resist the severe torsional strain to which it is necessarily subjected, without requiring the temper to be drawn so low as to impair its durability. For all tough materials, such as wrought iron, steel, brass, copper, etc., the size of tap drill for the full V-thread should be accurately that of the bottom of the thread. For cast iron, as the sharp edge of the full thread has not sufficient strength to prevent its stripping on the edges, the drill should be made of a size suitable for the Franklin Institute standard thread previously described, which will remove the weak and consequently superfluous edge.

(*To be continued.*)

Practical Hints to Practical Woodworkers.*

Woodworking is a branch of mechanical science in which it is important that the successful woodworker be not only possessed of a fair education, but he should also possess a thorough practical knowledge of those forces with which he is necessarily obliged to come in contact or to contend with. One of the most common, and at the same time one of the most important forces that he has to deal with comes properly under the head of centrifugal force. The speed at which all woodworking machinery is necessarily run, especially the cylinders and cutter-heads, should admonish the careful and experienced woodworker who has made the subject of central forces his study that there is a point where it is not safe to go beyond in speeding machinery. A careful and intelligent woodworker will never allow a machine under his charge to be speeded beyond the limit of safety, no matter whether it be a cutter-head or a pulley, for all are subject to the same laws of motion. At the same time, while excessive speed should be avoided, not only for safety, but economy, yet it is a well-known fact that the success of all machinery that comes under this head depends almost entirely upon the proper and most economical speed, which will be neither too fast nor too slow. A machine of any kind when run beyond a certain maximum speed will never perform as perfect work, to say nothing of the danger from centrifugal strain, as one that is run at the speed best adapted to its work and strength, as well as its solidity; and in many instances where a machine is light and lacks solidity, although the cylinders, cutter-heads, and pulleys may be sufficiently strong to stand the highest maximum speed, yet the lack of solidity may cause sufficient vibration in the whole machine to materially interfere with the quality of the work, and such machine, in order to obtain the best results, should be reduced to a speed that is best adapted for it.

While it is true that a strong heavy machine of good construction, with the cylinders and all other moving parts in perfect balance, will stand a greater maximum speed with good results than one of not the same weight and solidity, yet there is a point in the speed which the strongest machine should never go beyond. Nothwithstanding that the catalogues of certain manufacturers may state that their machines may be run at a certain speed and perform perfect work, yet the experience of some of the best practical woodworkers in the country has proved that such statements are not always to be relied upon; therefore, the experienced practical woodworker should be able to judge of the best speed to adapt the machine to his work, independent of all such statements. Again, all extremes should be avoided. A machine that is run too far below a fair maximum speed will not perform as good work as otherwise; besides, the quantity turned out will not be sufficient to make it profitable, for the reason that the cost for attendance is the same whether the machine will dress 5000ft. of lumber in ten hours or 10,000ft. in the same time. The fact is, all manufacturers of woodworking machinery are not practical woodworkers, and as a rule they are not always as competent to judge of the best speed to run a machine in order to adapt it to all the different classes of work, and the different conditions under which it is obliged to run, as the practical woodworker who has had years of experience in this particular class of work. Again, the experienced practical woodworker who understands the principles and power of centrifugal forces will also understand that it is not always prudent and safe to speed a machine to the full extent of its powers of endurance, for the reason that with the best regulated power there is always a liability for more or less variation in the speed; and there is no class of machinery where there is a greater variation in the demands upon the driving power than is found in planing mills and other woodworking establishments where heavy machines and saws are constantly being stopped and started suddenly, and where a machine is speeded to its utmost limit of safety, with but little margin to spare. A slight variation in the speed of the engine, if but for a moment, may carry it beyond that point, with perhaps disastrous results; and it is a fact that in almost every case where knives have been thrown off or pulleys bursted, it has occurred when the machines were running idle. It is not only in the liability of bolts breaking and knives being thrown off from the cylinders by centrifugal strain, but pulleys, both of wood and iron, whether they are attached to the machine or the line of shafting, are subject to the same laws and are just as liable to burst from excessive speed as the cylinder or cutter-head. Pulleys attached to the line of shafting, although not running the same number of revolutions per minute, yet their larger diameter causes the rim to move through space at the same, and not infrequently at a greater velocity; and the fact that a number of cases have occurred quite recently where large pulleys and fly-wheels have bursted, and in some cases with disastrous results to both property and life, is sufficient to establish the fact that the laws of centrifugal force cannot be violated with impunity.

While it is of the utmost importance that all pulleys belonging to the line shafting, whether of wood or iron, should be sufficiently strong to withstand not only the greatest amount of centrifugal strain to which they are liable to be subject, and at the same time perform the work required of them, they should also be in perfect running balance, for it is well known that an unbalanced pulley running at a high rate of speed not only causes a vibration sufficient to shake the whole building—which is detrimental to the whole structure,—but also seriously interferes with the working of the several machines necessarily affected by it. Again, the centrifugal strain upon such pulleys is much greater than upon those which are in perfect running balance. Manufacturers of pulleys, iron ones especially, are not sufficiently careful in making the rims of a uniform thickness; and it is quite common to find pulleys of 30in. diameter and over with a width of face of from 8in. to 12in., with a difference in the thickness of the rim upon opposite sides of ½in. While such pulleys may be balanced approximately by riveting weights upon the light side, yet they never can be brought to the same perfect running balance as those of an equal thickness on all sides. To obtain the best results, all such pulleys should be turned upon the inside as well as the outside of the rim. This may be objected to by some, who may claim that turning both sides not only involves unnecessary expense, but also weakens the rim; but this argument is not well founded. The fact is, the rim of a pulley is no stronger than its thinnest part; and where a pulley is thin upon one side and thick upon the other, the simple fact of reducing the thick side to correspond with the thin side does not weaken it in any way, but on the contrary, by reducing the weight of the whole rim, the centrifugal strain is reduced just in proportion to the weight, and the pulley is thereby rendered stronger in proportion to withstand the strain that is brought to bear upon it. There is no disguising the fact that the careless and imperfect manner in which iron pulleys have been fitted up in not only the balancing, but also in the turning, has had much to do with the success which the wood pulley has met with among the woodworkers.

* By C. R. Tompkins, in the "Age of Steel."

Trade Notes.

The John Cockerill Company, of Liege, Belgium, have secured an order for 700 tons of rails for Brazil.

Messrs. D. Stewart and Co. Limited, London-road Ironworks, Glasgow, have received the order for the large engines for the new rolling mill at Wishaw.

Messrs. J. and R. Houston, Cartsburn Foundry, Greenock, have secured the contract to erect the fireproof works and machinery for the new grain warehouse at Greenock.

Messrs. R. D. Smellie and Co., electrical engineers, Glasgow, have just completed a second set of arc lighting plant for the ironworks of Messrs. David Colville and Sons, Motherwell.

Messrs. Hawthorn, Leslie and Co., Newcastle-on-Tyne, have contracted to supply the engines, etc., for the first-class torpedo gunboat "Hussar," which is to be built at Devonport.

Mr. E. S. Bond, who makes a speciality of wire-working machinery, has removed his works from Lower Hurst-street East, Birmingham, to the Crown Machine Works, Booth-street, Handsworth, adjoining Handsworth station.

Messrs. Piercy and Co., Broad-street Engine Works, Birmingham, with a view to the extension of their ironfoundry, have acquired the brassfoundry and brassfitting works carried on by Mr. George Glydon, Colmore Works, and which are contiguous to their works.

Mr. John Macdonald, engineer, Glasgow, informs us that orders have been received from the Little Chute Paper and Pulp Mills Company, Wisconsin, U.S.A., for twenty "Achilles" turbines, each 54in. diameter; four 48in. diameter, and one 27in. diameter. An order for six turbines 51in. diameter, and one 39in. diameter, has also been received. If working on a 20ft. fall, they could develop 12,800H.P.

Messrs. John Shaw and Co., Maryhill Ironworks, Glasgow, request us to state that Mr. Robert Craig has retired from the firm. Mr. Thomas Campbell, who for many years has had the entire management of the business, will now be proprietor of the works and sole partner of the firm. This firm during the last few years has been entrusted with many large contracts, and has special facilities for the rapid production of cast-iron gas and water pipes.

Having regard to the enormous circulation of The Mechanical World, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if Mechanical World readers will kindly bear this in mind as occasion arises.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 85, Strand, London, or New Bridge-street, Manchester.

The Design and Construction of Stationary Engines.—LI.

FIGS. 217 and 218 show elevation and plan of a very good form of three-part bearing pedestal, adjustable in all directions and without top brass. This pedestal is for a bearing 10in. diameter by 18in. long. The cap lips over at the ends, and is bolted hard down on top of the pedestal, metal to metal. The wedges are adjustable by means of two setting-down screws and a centre lifting screw; the wedges are solid wrought-iron blocks.

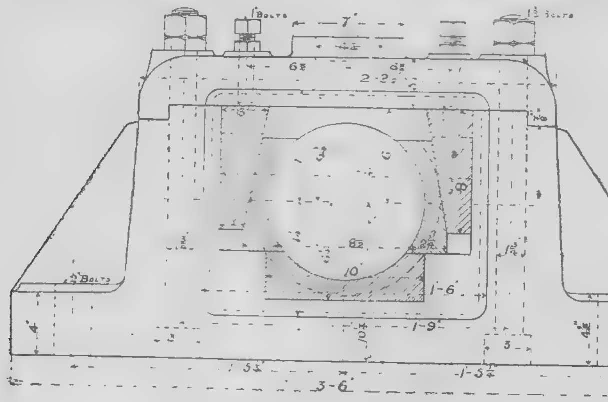
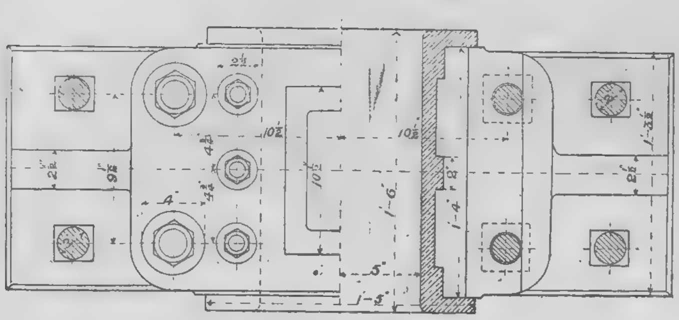


FIG. 217.

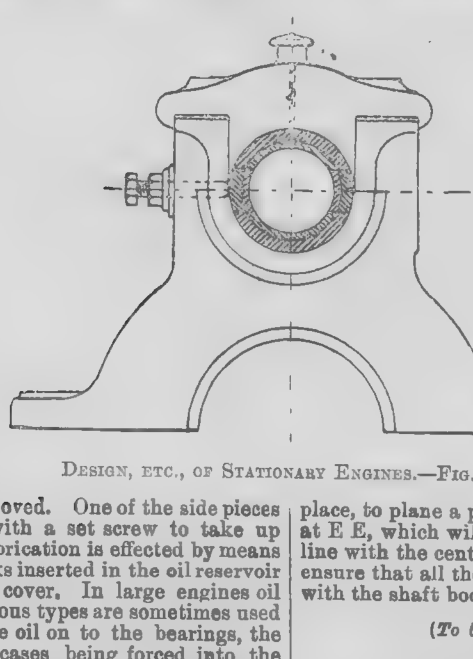


DESIGN, ETC., OF STATIONARY ENGINES.—FIG. 218.

In pedestals of this description the thickness of the brasses for journals of 4in. diameter and upwards may be = $\frac{1}{10}$ D + $\frac{1}{4}$in. at the bottom, where D = diameter of bearing, and $\frac{1}{10}$ D at the sides.

The cap in this pedestal is secured by four $1\frac{3}{4}$in. bolts with double nuts, and the pedestal itself bolted to the engine bed by four 2in. bolts. Many makers prefer to fit four-part brasses into their pedestals; and these are necessary should there be any lifting tendency on the shaft. The methods of adjustment are very various.

Fig. 219 is a Continental design of such a bearing, similar in construction to Figs. 213 and 214. The brasses are made of circular form and in four pieces, which facilitates removal without displacing the shaft to any great extent. When it is necessary to remove the brasses without taking out the shaft, the latter only requires to be raised a very small amount, when the brasses can be slipped round the



DESIGN, ETC., OF STATIONARY ENGINES.—FIG. 219.

shaft and removed. One of the side pieces is provided with a set screw to take up wear. The lubrication is effected by means of cotton wicks inserted in the oil reservoir formed in the cover. In large engines oil pumps of various types are sometimes used for forcing the oil on to the bearings, the oil in some cases being forced into the bottom of the bearing, from whence it is passed round the shaft, keeping it well lubricated. The bottom portion of the brasses supports the downward pressure of the shaft, fly-wheel, etc., and its bearing surface should not be less than that contained within an angle of 90°. The top brass is intended to resist any upward pressure, but, as already explained, this is seldom required with engines having heavy fly-wheels. The side brasses should be capable of separate adjustment, either by means of screws or wedges. In pedestals of great width four wedges are used, one at each of the four corners, so as to support the brasses close up to the edge of the bearing. In bearings of this description, care has to be taken when wear of the bottom brass occurs to adjust the level of the side brasses, so that they fit centrally with the shaft, or trouble may be experienced in working. Fig. 220 illustrates this point. When first set to work the shaft centre was at A, and its outer diameter is represented by the dotted circle; gradually wear takes place, and the centre of the shaft lowers to B, its outer diameter now being represented by the full line. The shaft has worn into the bottom brass, and also worn off the lower corners of the side brasses at C C, leaving a corresponding space above the centre at D D. The displacement of the shaft is shown somewhat exaggerated in the figure, to more clearly show the fault.

The result of such wear is to cause heavy pounding of the shaft at every revolution. If the attempt is made to stop the pounding by setting up the wedges, the friction will be greatly increased by the excessive pressure on the corners C C, causing heating. Any amount of tightening, which the bearings may stand and still run cool, will not in such a case cure the evil.

It is necessary, when this wear takes place, to plane a portion off the side brasses at E E, which will bring their centres in line with the centre of the shaft, and thus ensure that all the sections are concentric with the shaft body.

(To be continued.)

MESSRS. CROMPTON AND CO., of Chelmsford, use a small fox-terrier dog for running pilot lines through underground conduits. A string is tied to the dog's collar, and he enters at one end and comes out at the other carrying the line with him.

Improved Governor Regulator.

THE speed regulation of steam engines has received from time to time a considerable amount of attention at the hands of inventors, but during the last decade the efforts to improve the action of engine governors have been almost unremittent. The system usually adopted during recent years to secure this end has been to supplement the action of the ordinary governor by adding an auxiliary controlling or regulating device

With governors of the types commonly met with, the plane in which the balls revolve

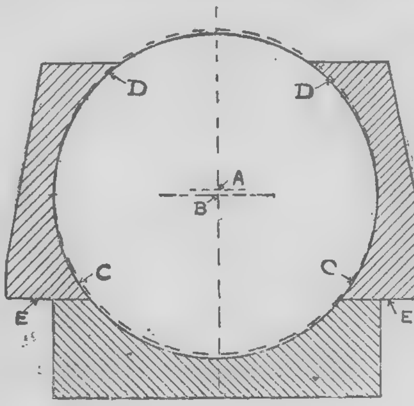
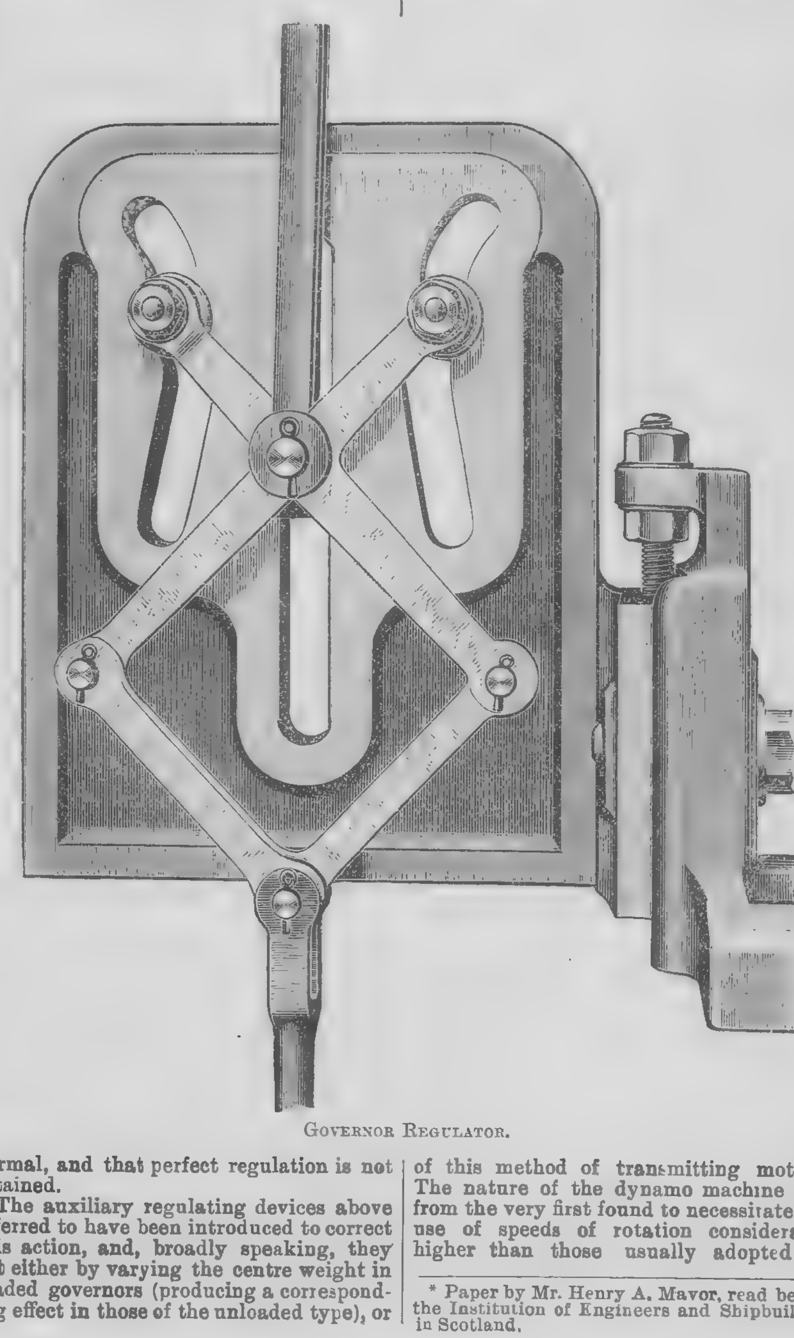


FIG. 220.

is, as is well known, dependent upon the speed of revolution. It is clear, therefore, that when the engine is driving a constant load, and with a uniform steam pressure, the balls will constantly revolve in one plane. Should, however, part of the load be thrown off, the balls rise by reason of the consequent increase in speed, until, owing to the diminution of the steam supply, a state of equilibrium is again attained. But, as we have seen, the balls now revolve in a higher plane than that corresponding to the normal speed. It follows, therefore, that the speed of the governor, and consequently of the engine, is also above the



GOVERNOR REGULATOR.

normal, and that perfect regulation is not attained.

The auxiliary regulating devices above referred to have been introduced to correct this action, and, broadly speaking, they act either by varying the centre weight in loaded governors (producing a corresponding effect in those of the unloaded type), or by varying the length of the rod which communicates the vertical motion of the governor sleeve to the cut-off gear or throttle valve. It is a device on the latter principle that we have on the present occasion to bring before the notice of our readers, and which is shown in the accompanying illustration. It is the invention of Mr. Alexander Rodgers, and is being made by Messrs. Geo. Burns and Sons, Burnside Works, Galashiels. As will be seen, the rod from the governor shown at the upper part of the illustration is connected to a pair of crossing levers by means of a joint pin. To the lower ends of these levers, two other short levers are jointed, these latter at their lower ends being also coupled together and to the valve rod. The upper ends of the long levers are provided with friction rollers or bowls which play up and down the curved slots in the foundation plate. A vertical slot is provided in the centre of this plate to form a guide for the lower end of the governor rod. It will be clear that as the movement of the outer ends of the long levers is controlled in the manner shown, any vertical movement of the governor rod will cause virtually an alteration of the length of the connection between the governor and cut-off gear, so that a small movement of the former may be made to give a rapid and extensive movement to the latter, thus securing a much closer regulation of speed than can possibly be obtained by governors of the ordinary type. As will be seen, the foundation plate is attached to the engine framing in such a way as to allow it to be adjusted vertically, and locked in position by the two nuts, as shown. The device has, we understand, been applied with very satisfactory results to a mill engine fitted with McNaught's patent cut-off gear; but it can be readily applied to any ordinary governor. As will be seen, there is nothing likely to become easily deranged, while the whole attachment is very simple and compact.

On Belting for Machinery.*

THE use of belting for driving dynamo machines marks an era in the application of this method of transmitting motion. The nature of the dynamo machine was from the very first found to necessitate the use of speeds of rotation considerably higher than those usually adopted in

* Paper by Mr. Henry A. Mavor, read before the Institution of Engineers and Shipbuilders in Scotland.

engineering practice, except in cases of centrifugal machinery and of other machinery of so small power as to call for no special arrangements for driving. For many years after the dynamo became a marketable commodity all such machines were driven by belts or ropes. Of late years many machines, large and small, have been driven by direct connection with the engine crankshaft, and a few by gearing. Of course increased efficiency is obtained by direct connection. Allowance is usually made for an additional loss of at least 15 per cent. in belt and journal friction.

Notwithstanding the many advantages of direct driving, the largest, as well as the smallest, dynamos are still driven by belts or ropes.

There is a sound reason for this. A dynamo machine has the property of instantaneously becoming capable of absorbing a quantity of power limited only by the ultimate strength of its moving parts and the resistance to heat of its insulation and metallic conductors.

In this respect it differs from all other machinery. The friction of a hot bearing brings a machine to rest with comparative slowness. A short circuit in a dynamo has instantaneously to smash or melt something either in the machine or driving gear. The study of belting is, therefore, of great importance and interest to the electrical engineer, and it is because I have taken an interest in this subject for the past fourteen years that I ventured to respond to the invitation of the secretary, and to record my experience.

The most difficult cases of simple belt transmission (as distinct from angular and complex belt gear) are, of course, where the pulleys to be driven are small and the distances between the driving centres are short.

These are precisely the cases which the electrical engineer meets with most frequently.

Successful results are unfortunately only to be attained by the tedious process of trial and error which gradually trains and perfects what an eminent engineer has called the engineering eye. The conditions of practice are so variable that the most exact and careful calculations are only approximate guides.

There are, however, several broad principles established and recorded which it is well to know, and which qualitatively, if not quantitatively, direct us towards the desired results.

These principles are discussed in the articles on belting in Spon's "Dictionary of Engineering," which contain, I think, in original form or in quotation, all the useful matter that has been published on this part of the subject. The base of all belting calculations is the formulæ given by Professor Rankine in his "Treatise on Machinery and Millwork," p. 351.

f = the coefficient of friction.

θ = the ratio of the length of the arc of contact with the pulley to the radius of the pulley.

n = the arc of contact between the band and the pulley expressed in turns and fractions of a turn.

(1) $R = T_1 - T_2$ = the total friction between the band and the pulley.

(2) $$\frac{T_1}{T_2} = e^{f\theta} = 10^{2{\cdot}7288 fn}$$

or, $$\log \frac{T_1}{T_2} = 2{\cdot}7288\, fn$$

(3) $$\frac{T_1 + T_2}{2R} = \frac{e^{f\theta} + 1}{2\,(e^{f\theta} - 1)}$$

We see from this :—

1st. That the power which may be transmitted by a belt and pulley is determined by the difference between the tensions of the driving side and of the following side of the belt.

2nd. That the ratio of these tensions is determined by two things—viz., the coefficient of friction (that is to say, the ratio: friction or resistance to relative motion of the surface) total pressure forcing the surfaces together, and the angle embraced by the belt.

It will be at once seen that the value to be given to the coefficient of friction is of vital importance in the beginning of the calculation. This value is precisely the element in the whole question which it is most difficult to determine.

A great deal has been written on the subject, but the authorities are hopelessly at variance in their results. The reason is not far to seek. The value for the friction between a belt and a pulley, determined by any set of experiments, applies only to that particular belt and pulley, under the conditions of the individual experiments. Among the variable elements in these conditions which affect the results are :—The condition of the respective surfaces as regards smoothness, dryness, and temperature, and the flexibility of the belt in question.

The results obtained by different experimenters vary as much as between the values of 1 and 3.

The most exhaustive set of experiments with which I am acquainted, carried out under conditions similar to those of actual practice, has been carried out by Messrs. William Sellers and Co., and recorded by Wilfred Lewis, of Philadelphia, in the Transactions of the XIII. Meeting of the American Society of Engineers, Chicago, 1886. These gentlemen succeeded in producing sets of conditions such that, with the same belt, they were able to vary the apparent coefficient of friction from 0·156 to 1·42, or nearly 1000 per cent. Such a variation as this in a vital factor of the calculation would seem to reduce calculation to an absurdity. The case is not, however, altogether hopeless. Although the variation is enormous, we have a basis of approximation in the fact that it is not difficult to discover for any sample of belting what is the least value which we can give to the friction factor. It is well known to everyone who has experience in using belting that the first run of the belt is the worst, as regards its driving properties.

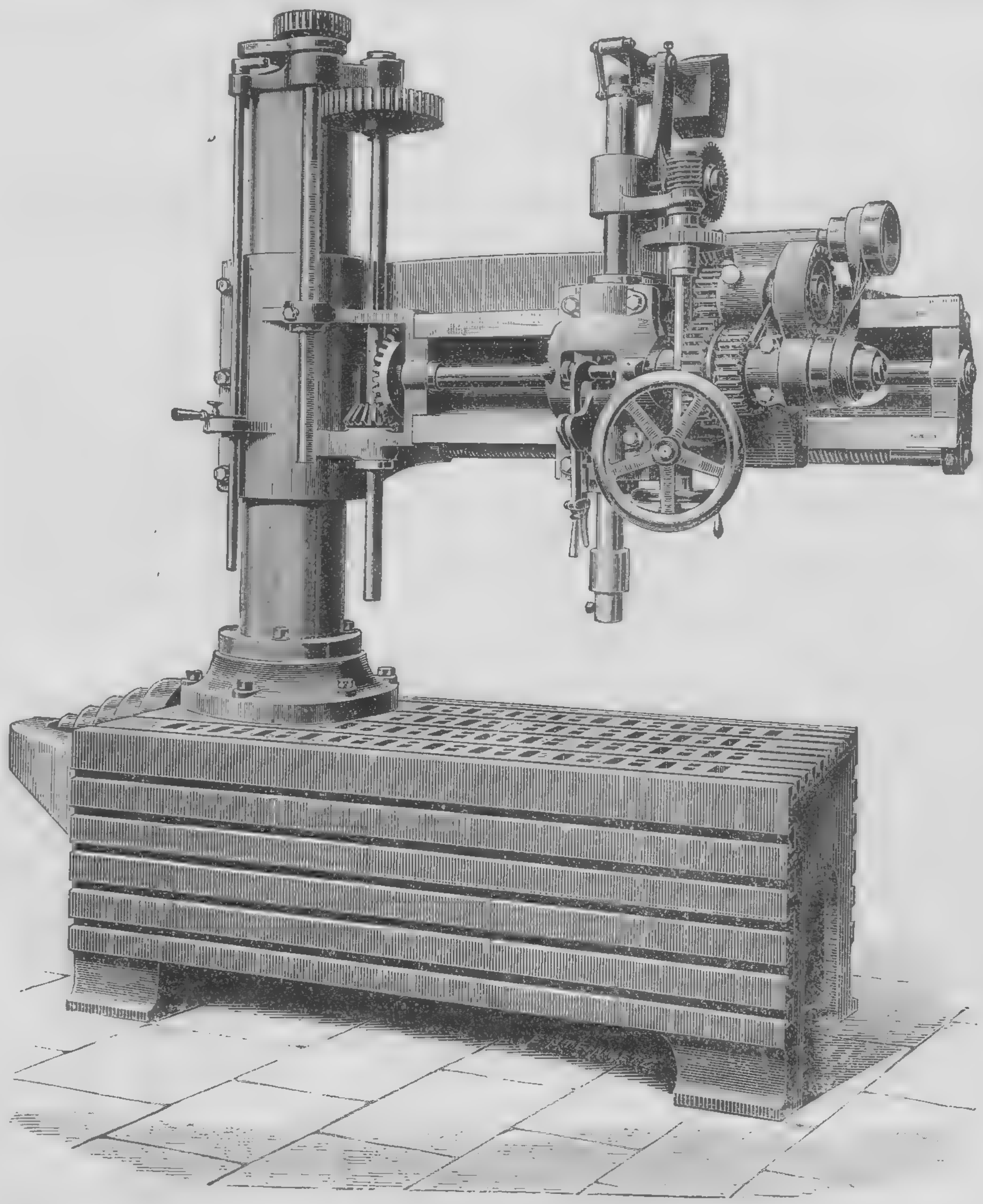
(To be continued.)

Society of Engineers.

The next ordinary meeting of this society will be held at the Town Hall, Westminster, on Monday, April 10, when a paper will be read on "The Cleaning of Tramway and other Rails," by Mr. H. Conradi, of which the following is a synopsis :—Street cleaning appliances in general —Their influence on the condition of tramway rails—Local authorities' regulations —Various machines for cleaning tramway rails, including those of Green, Townsend, Rayner and Edwards, Dickinson, Record and Jordan, Presser, and Nobes and Jackson—All of rigid construction and incapable of adaptation to deviations of rails, etc.— The author's machine described and illustrated—Based on principles of elasticity— Experiments with same—Application of the system on Reading tramways—Later modifications of the system—Cost of various systems of cleaning tram rails—Advantages of the author's system.

Radial Drilling Machine.

Herewith we illustrate an improved form of radial drill, made by the Britannia Company, Colchester. It has a foundation table of box form, with planed T slots on top face and each side for securing the work, mounted on which is a turned column, carrying within it the vertical driving shaft, geared up with mitre gearing, and around which revolves a turned external column, accurately fitting it. The latter carries a radial arm, made to rise and fall by self-acting arrangement by power. Fitted to the arm, and gibbed to fit a planed parallel slide, is a saddle carrying the drilling spindle, which is arranged to be driven by single or double gear, and with reversing motion to drive right or left, or remain stationary, without stopping the machine. This enables tapping and studding to be rapidly done by the machine, and also permits the drill to be quickly withdrawn from the hole. The spindle is also counterbalanced by weight and lever, and fitted with self-acting feed motion by rack and pinion with engaging clutch. The horizontal driving shaft, fitted into the foundation bed, carries a driving cone having five speeds, giving, with the double gear, ten changes of speed. The spur gearing is machine-cut out of the solid, the smaller gears being of mild steel. The mitre gearing is of crucible cast steel.



Radial Drilling Machine.

Arrangement of Cylinders and Cranks in Triple-expansion Marine Engines.

(Continued from page 127.)

In the common arrangement of cylinders —viz., high-pressure, intermediate-pressure and low-pressure—the cranks may be in the sequence of high-pressure, low-pressure and intermediate-pressure. The high-pressure valve chamber, instead of being in the usual position forward of its cylinder, may adjoin the intermediate, and the advantages stated in the preceding example be thereby somewhat attained; but in both these arrangements we have the objection of two sets of eccentrics being placed upon one section of shaft, an objection which not only prohibits the cranks being readily interchanged, if required, but is usually in the way of a coupling; so much so that it is frequent, in engines of this description, to see the two forward cranks in one forging, the after one only being separate. To accommodate the valves being in a position not over the line of shafting, some modification of the valve gear is entailed, the common link motion and double eccentrics not being applicable for driving them when in that position without the intervention of bell cranks and other objectionable features. There are several capital arrangements of the single eccentric dynamic motion extant which answer very effectually, and are as comprehensible and easy of adjustment as our old friend the Stephenson link. These are the systems which are most frequently seen in triple-expansion engines. For compactness, beauty of design, and general efficiency the latter commends itself to the writer. In cargo boats, where space is not so much a consideration, the valves may be directly over the shaft; and where a light and airy engine room is a desideratum the plan of placing the high-pressure cylinder central is very effective. This design gives an open front and provides the valuable quality of accessibility for the purposes of overhaul. The important advantage is also gained of having the steam passages between the high-pressure and intermediate valve chests very short and direct, while the low-pressure crank may be arranged to follow the high-pressure at 240°, and thus secure the benefit of a steady intermediate initial pressure, as mentioned in the foregoing part of this paper. The distance between the intermediate-pressure and low-pressure cylinders—having only the high-pressure between—is not great, so that for the benefits derived from contiguity of valve chambers this design is preferable to the one where the low-pressure cylinder is central.

The paper was illustrated by numerous diagrams, to which the author referred as follows :—It may be well to call to mind a common error in measuring indicator diagrams. The usual plan is to divide the figure into ten equal parts and measure the distance enclosed by the top or steam line and the bottom or exhaust

line for the effective pressure in the cylinder. Where the exhaust lines from both top and bottom of cylinder coincide this method produces a near enough result for general purposes; but the *correct* pressure on the piston is obtained by measuring from a fixed base—either the atmospheric or perfect vacuum line—and deducting the back pressure taken from the other end of this cylinder. In some engines where the receiver pressure fluctuates, the miscalculation may be considerable if this is not done. The necessity is apparent when we consider that while the indicator is open to one end of the cylinder while the steam line is being traced, the back pressure affecting that steam line is on the other side of the piston, and therefore to be measured from the other diagram. Again, in calculating stresses on the crankpin, it is not correct to divide the indicator diagram into *equal* parts and measure the ordinates, as is usually done for the mean pressure; for owing to the obliquity of the connecting-rod, the piston moves through variable distances for similar angular movements of crank.

(*To be continued.*)

Slide-rule Illustrations.

[CONTRIBUTED.]

THE object of the present paper is to present a few examples illustrating the utility of the slide rule in dealing with some of the problems which present themselves to the student and the practical engineer. A tolerably lengthened experience has taught the writer that the slide rule affords one of the readiest methods of solving many of the problems which occur in daily practice amongst engineers, so far as calculation is concerned; and as the literature bearing on the subject is not as yet very abundant, the following examples, it is hoped, may be of some interest to those engaged in such pursuits.

The examples here given are worked out by the aid of a Tavernier-Gravet rule (which statement must not be held as disparaging to other forms or makers), but the formulæ given, it is hoped, will be found applicable to the ordinary form as well. At the same time, these examples presuppose some acquaintance with slide-rule manipulation.

A convenient starting point will be the consideration of a formula for finding the horse-power of a steam engine.

The I.H.P. may be found easily by at least two methods, the first of which is the slide rule adaptation of the usual $\frac{2\ \mathrm{PLAN}}{33{,}000}$ but which for our purpose we write $\frac{\mathrm{SPA}}{33{,}000}$ where S = speed of piston, P = effective pressure of steam per square inch, and A = area of piston in square inches, the working of which on the rule is shown in the following general formula, requiring two settings or movements of the slide:—

$$\text{(1)}\ \begin{array}{lll} A & 33{,}000 & \mathrm{P} \\ \hline B & \mathrm{S} & x \end{array} \qquad \text{(2)}\ \begin{array}{ll} 1 & \mathrm{A} \\ \hline x & \mathrm{I.H.P.} \end{array}$$

x here denotes the result found by the first operation. Take an example:—S = 360ft., P = 80lb, A = 114·5sq. in. Substituting these values we have

$$\text{(1)}\ \begin{array}{lll} A & 33{,}000 & 80 \\ \hline B & 360 & 873 \end{array} \qquad \text{(2)}\ \begin{array}{ll} 1 & 114{\cdot}5 \\ \hline 873 & 100\mathrm{I.H.P} \end{array}$$

Example 2.—S 195ft., P 60lb., A 1810sq. in. Required the I.H.P.

$$\text{(1)}\ \begin{array}{lll} A & 33{,}000 & 60 \\ \hline B & 195 & 354{\cdot}5 \end{array} \qquad \text{(2)}\ \begin{array}{ll} 1 & 1810 \\ \hline 354{\cdot}5 & 641{\cdot}5\mathrm{I.H.P.} \end{array}$$

The second method, which the writer generally prefers, may be thus written:—$\frac{\mathrm{SP}d^2}{42{,}016}$, where d = diameter of piston, S and P as before. Taking now the first example given, and putting 12 07in. as the diameter, the working becomes:—

$$\text{(1)}\ \begin{array}{lll} A & 42{,}016 & 80 \\ \hline B & 360 & 6855 \end{array} \qquad \text{(2)}\ \begin{array}{lll} A & 1 & \\ \hline B & 6855 & 100\mathrm{H.P.} \\ \hline D & & 12{\cdot}07 \end{array}$$

If strict regard were had to the position of the numbers, the diameter on D would be shown at the extreme left; but the order, rather than the position, concerns us at present.

On the ordinary engineer's slide rule, the H.P. is found on C; but by adhering to line B in our formula, either form of rule may be used. On the Gravet rule also lines C and D may be used sometimes in the first operation with advantage.

We may now write our general formula thus:—

$$\text{(1)}\ \begin{array}{lll} A & 42 & \mathrm{P} \\ \hline B & \mathrm{S} & x \\ \hline D & & \end{array} \qquad \text{(2)}\ \begin{array}{ll} 1 & \\ \hline x & 1\mathrm{H.P.} \\ \hline & d \end{array}$$

42 is here quite accurate enough instead of 42,016, which is an equivalent for $\frac{33{,}000}{0{\cdot}7854}$

Example 3.—Given a compound engine, cylinders = 28in. and 36in. diameter, P = 35lb. and 21lb. respectively, S = 370ft. Required the horse-power.

$$\text{(1)}\ \begin{array}{llll} A & 42 & 21 & 35 \\ \hline B & 370 & 1850 & 3083 \end{array} \qquad \text{(2)}\ \begin{array}{lll} A & 1 & \\ \hline B & 1850 & 240\mathrm{H.P.} \\ \hline D & & 36 \end{array}$$

$$\text{(3)}\ \begin{array}{lll} A & 1 & \\ \hline B & 3083 & 242\mathrm{H.P.} \\ \hline D & & 28 \end{array}$$

240 + 242 = 482, total H.P.

Example 4.—In a triple-expansion marine engine d = 40in., 66in., and 100in., S = 774ft., H.P. developed in each cylinder = 2250. What are the mean pressures?

Suppose we take the L.P. cylinder; we have then

$$\text{(2)}\ \begin{array}{lll} A & 12{\cdot}2 & 42 \\ \hline B & 225 & 774 \end{array} \qquad \text{(1)}\ \begin{array}{lll} A & 1 & \\ \hline B & 225 & 2250\mathrm{H.P.} \\ \hline D & & 100\mathrm{dia.} \end{array}$$

Inverting the slide we have the remaining mean pressures thus:—

$$\begin{array}{llll} g & 76{\cdot}25 & 28 & 12{\cdot}2\ \text{mean pressures.} \\ \hline D & 40 & 66 & 100\ \text{diameters.} \end{array}$$

These results may be verified by taking each cylinder separately and finding the mean pressure as shown. The above is recommended, however, as the simplest method.

Example 5.—In a triple-expansion engine the mean pressures are 68, 27·8 and 11lb., S = 745ft. Find the diameter of cylinders to develop, say, 1835H.P. each; total 5505. Here we have

$$\text{(1)}\ \begin{array}{lll} A & 42 & 68 \\ \hline B & 745 & 1205 \\ \hline D & & \end{array} \qquad \text{(2)}\ \begin{array}{ll} 1 & \\ \hline 1205 & 1835 \\ \hline & 39\mathrm{dia.} \end{array}$$

Inverting the slide as before, we get

$$\begin{array}{llll} g & 68 & 27{\cdot}8 & 11\ \text{pressures.} \\ \hline D & 39 & 61 & 97\ \text{diameters.} \end{array}$$

As the mean pressure is an important factor in such calculations, it may be well to give a formula for finding it here, the initial pressure and cut-off being given. To facilitate such calculations, a table of constants is usually found in reference books, and availing ourselves of such aid we proceed as follows:—

Example 6.—Let the initial pressure (absolute) be 95lb., cut off at half-stroke. What will be the mean pressure during the stroke? Consulting our table, we find for two expansions, constant 0·846. Putting now I = initial pressure, P = mean pressure, our formula may be thus expressed:—

$$\begin{array}{lll} A & \text{constant} & 10 \\ \hline B & \mathrm{P} & \mathrm{I} \end{array}$$

Substituting the given values, we have

$$\begin{array}{lll} A & 0{\cdot}846 & 10 \\ B & 80{\cdot}4 & 95 \end{array}$$

Example 7.—Initial pressure = 160lb., cut-off at ⅓ stroke. Find mean pressure.

$$\begin{array}{lll} A & 0{\cdot}699 & 10 \\ \hline B & 111{\cdot}8 & 160 \end{array}$$

These results are to be understood as forward pressures; back pressure requires to be deducted to obtain the effective mean pressure.

In the absence of a table, the various constants may be easily found on the Gravet rule. Withdraw the slide to the right, and on the reverse side will be found a line of logarithms from 0 to 1000. Let us now try to find the constants used in the foregoing examples. Withdrawing the slide to $\frac{C\ \ 1}{D\ \ 2}$ we find on the reverse side, opposite the index, 0·301 as the log. of 2. Multiplying this by 2·302 we get hyp. log. 0·693, to which, adding 1 and dividing by number of expansions 2, we get constant 0·846. Similarly setting our slide $= \frac{C\ \ 1}{D\ \ 3}$ we find log. 0·477; and, going through the same process, we get constant 0·699.

Where such calculations are of frequent occurrence it may be worth while to put a series of points or lines on the upper edge of the rule, opposite the constants likely to be required. On the writer's own rule are engraved on the upper edge, above line A, points corresponding to 10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, and 80 per cent. of stroke, and on the lower edge similar points for 1, 2, 3, 4, 5, 6, 7 eighths of stroke. All that is now required is to bring the cursor or slider to these points, and read off the required pressures, the rule being set as directed—constants on A, pressures on B. The same may be done by taking a slip of card and laying it along the rule above line A, marking off the constants, care being taken to mark a point at 10 on A. This serves for setting the scale so formed always in position.

The terminal pressure, and also pressure at any point of stroke after cut-off, may be found by inverting the slide thus:—Let I = the initial pressure; T = the terminal pressure; S = the stroke in ft. or in.; P = the part of stroke completed before cut-off. We may then write our formula $\begin{array}{lll} A & \mathrm{P} & \mathrm{S} \\ \hline g & \mathrm{I} & \mathrm{T} \end{array}$.

Taking the data of Example 7, and assuming S = 48in., P = 16, we have

$$\begin{array}{lll} A & 16 & 48\ \ \text{inches} \\ \hline g & 160 & 53{\cdot}3\ \ \text{pressures} \end{array}$$

the pressures at any intermediate points also being found by inspection.

In designing triple-expansion engines (or compound of any form) it is sometimes desirable to see what initial pressures will give equal loads on the respective pistons. Taking Example 4, and assuming an initial pressure of 195lb. absolute, let us see what corresponding pressures for the intermediate and low-pressure cylinders will satisfy these conditions. Perhaps the simplest method is to invert the slide thus:—

$$\begin{array}{llll} g & 195 & 71{\cdot}5 & 31{\cdot}2\ \text{pressures} \\ \hline D & 40 & 66 & 100\ \text{diameters} \end{array}$$

There is another formula which, though more complex, has one advantage, as it gives the load in tons on a piston at a given initial pressure per sq. in. Let I = initial pressure in lb. per sq. in.; l = total pressure in tons on the piston; d = diameter of cylinder; 2852 = a constant. Our formula is written thus:—

$$\begin{array}{lll} A & 2852 & \\ \hline B & \mathrm{I} & l \\ \hline D & & d \end{array}$$

In the example under notice:—

$$\begin{array}{lll} A & 2852 & \\ \hline B & 195 & 109{\cdot}5\ \text{tons} \\ \hline D & & 40\mathrm{dia.} \end{array}$$

Sliding now the 109 5 tons over 66 and 100in., under 2852 we find the respective pressures 71·5 and 31·2 as before. Assuming these as initial working pressures, and expanding down to a terminal pressure of 8lb., would give us about 2 7, 2·3, and 3·9 expansions, or a total of 24.

In THE MECHANICAL WORLD for 25th November, a querist asked how he could find the diameter of H.P and M.P. cylinders from the following data:—Diameter of L.P. cylinder = 88in.; stroke, 5ft.; revolutions, 73; boiler pressure, 180lb.; 4500I.H.P.; cut-off in H.P. cylinder = 0 6 stroke.

Suppose we want about equal power developed in each cylinder, we have

$$\text{(2)}\ \begin{array}{lll} A & 11{\cdot}12 & 42 \\ \hline B & 1935 & 730 \end{array} \qquad \text{(1)}\ \begin{array}{lll} A & 1 & \\ \hline B & 1935 & 1500\mathrm{I.H.P.} \\ \hline D & & 88 \end{array}$$

180lb. boiler pressure will give us, say, 192 absolute, which at 1·66 expansions gives a terminal or back pressure of 115lb., which, deducted from 174·5, the mean forward pressure as found by the formula already given, leaves a mean effective pressure of about 60lb. for the H.P. cylinder. Inverting the slide now we set

$$\begin{array}{lll} g & 60 & 11{\cdot}12 \\ \hline D & 37{\cdot}9 & 88 \end{array}$$

The H.P. cylinder is thus found to be 38in., say. Rectifying the slide we now set

$$\begin{array}{llll} B & 1 & 2\ 5 & 5{\cdot}37 \\ \hline D & 38 & 60 & 88 \end{array}$$

If 60in. be taken as suitable for the intermediate cylinder, 24lb. will be the corresponding mean effective pressure.

Compound Expansion Engines.

(*Continued from page* 115.)

ALTHOUGH the quantity is exceedingly small, it may be as well to see what it will represent in temperature. We have in 1·44in. of cylinder section (69 92 sq. in. × 1·44) × 0·26 = say 26·18lb. cast iron, the specific heat of which is 0·123. Then (0·019552 ÷ 0·123) ÷ 26·18 = 0·006° of increased temperature, or from 299° to 299·006°, which manifestly can have no appreciable effect. This being the case it is clear that the maximum temperature of the cylinder cannot exceed that of the steam due to its degree of expansion, and that the condensation or transfer of heat from steam to cylinder and from cylinder to steam must be calculated on the differences due to these conditions.

Subtracting the mean of the terminal temperatures of spaces 1 and 2 from that of space 1, we have $344 - \frac{344 + 299}{2} =$ 22·5° as the effective difference; and while in space 2 the cylinder is absorbing heat from the steam, the latter is absorbing from the cylinder in space 1. From this it would appear that the alleged great difference between the steam and cylinder walls does not exist in reality; for if the above hypothesis be correct, the steam must be giving heat to one part and receiving from another part of the cylinder simultaneously, and in like amounts. Carrying out the idea to end of stroke, when the temperature has fallen to 161·4°, we find the difference between this and the initial temperatures of the several spaces to be 182·7° for first; 137·6° for second; 111° for third, and so on throughout all of the spaces, until finally it becomes but 3 6° between the initial and terminal in last space. It would seem, then, that the correct comparison of temperatures to ascertain the actual variation should be between a mean of the 25 terminals and the temperature due to the mean pressure for the entire stroke, and these we find to be 206·5° and 231° respectively—the difference being 24·5°, which agrees very nearly with the comparison between the first two spaces.

Let us now see, by calculation, what will be the heating and cooling effects on the surface of cylinder by the above variations of temperature of the steam, and also that on the steam by the cylinder. To simplify the calculation we may assume the capacity of the steam for imparting and absorbing heat to be greater than that of the cylinder, or, in other words, that the transmission is governed entirely by the capacity of the iron.

Referring again to the first and second spaces and using the previous figures, the loss by space 1 for the 12·4° between the initial and mean temperatures, as limited by the conductivity of the iron, will be as follows:—The area of surface, 0·647 sq. ft.; time, 0·000005½ hour; thickness of metal, say one-half that of the cylinder, or ½in. Then $12{\cdot}4^\circ \times \left(\frac{233}{0{\cdot}5} + 0{\cdot}647 \times 0{\cdot}000005\tfrac{1}{2}\right) =$ 0·02056 heat unit. This will decrease the temperature of, say, one-half the weight of iron in whole section of cylinder by $\left(\frac{0{\cdot}02056}{0{\cdot}123} \div \frac{26\ 18}{2}\right) = 0{\cdot}01265^\circ$ in space 1, and increase that of space 2 by the same amount. To find the mean effect for the entire stroke by the same method, we subtract the temperature of total mean prespressure from the average of temperature due to mean pressures of the 25 spaces to obtain the mean variation. We have for the latter 262·45°, and from the table 231° for the former, the difference being 31·45°. The weight of one-half the thickness of cylinder is $\frac{69\ 92}{2} \times 36 \times 0{\cdot}26 = 327{\cdot}58$lb., and that of ½in. thickness of piston and cylinder head is $(333\tfrac{1}{3} \times 2 \times \tfrac{1}{2}) \times 0{\cdot}26 = 86\ 67$lb. = 414·25lb. total. The total area of cylinder, cylinder head, and one side of piston will be

$$\left(\frac{20{\cdot}6 \times 3{\cdot}1416}{144} \times 36\right) + \left(\frac{333\tfrac{1}{3} \times 2}{144}\right)$$

= 20·81 sq. ft. The time of stroke is $\frac{1}{66 \times 2 \times 60}$ = 0·00014 hour. Then $\left(\frac{233}{0{\cdot}5} \times 20{\cdot}81 \times 0{\cdot}00014\right) \times 31{\cdot}45^\circ =$ 42·698 heat units as the quantity of heat lost by the warmer and absorbed from the steam by the cooler portions of the cylinder.

Reducing this to temperature, we have $\frac{42{\cdot}867}{0{\cdot}123} \div 414{\cdot}25$ 0·841° as the mean loss and gain by cylinder. Of course the effect of this interchange of heat upon the temperature of the volume of steam will not be the same as we have found with relation to the cylinder, owing to the difference of specific heat, etc.; but it is clear that a variation of less than 1° cannot possibly account for the loss of tension by the expanding steam, nor for the amount of condensation sure to occur when the expansion is carried to the extreme limit, as in the case under consideration.

(*To be continued.*)

Junior Engineering Society, New Swindon.

THERE was a good attendance at the last ordinary meeting of this society for session ending April, 1893, in the Lecture Hall of the Mechanics' Institution, on Friday, March 24. Mr. W. L. Holt presided. Mr. Gange was unanimously elected auditor of the accounts of the society. Messrs. T. C. Davison, Wh. Ex., and A. E. Leader read very able and instructive papers, entitled "The Lever and the Inclined Plane" and "The Wheel and Axle and General Applications of Mechanical Principles," respectively. In the treatment of the first named subject in his paper Mr. Davison was enabled, by means of some excellent working models, to very clearly demonstrate the movements

and results of several arrangements of levers to produce rectilineal motion, notably those of Watt, Scott-Russell, and Peaucellier, and arrangements for producing rotary motion were also introduced and described. By the aid of diagrams, he fully explained the principles and applications of the inclined plane with special reference to the theory and forms of screw threads.

Mr. Leader also produced numerous drawings and diagrams, which materially helped him in his very interesting paper, in the first portion of which he dealt fully with the principles of the many mechanisms which may be embodied in the arrangement familiarly known as "the wheel and axle." He then proceeded to explain the movements of, and to describe, several arrangements for the conversion of motion, and, as applications for the production of a quick return motion, he instanced the use of cams, eccentric spur wheels, and Whitworth and Collier's arrangements. Mr. Leader's explanation of Prof. Willis's mechanism for gradually altering the stroke, excited general interest, and in conclusion he advanced what, in his opinion, were the lines to be followed to ensure success in mechanical invention. The proceedings terminated with a very hearty vote of thanks to Messrs. Leader and Davison.

Metal Trade Memoranda.

The Knutton Forge, near Newcastle-under-Lyme, which is one of the largest ironworks in Staffordshire, is, it is stated, about to be restarted.

Messrs. John Summers and Sons, Globe Ironworks, Stalybridge, makers of black sheet iron, are about to commence the manufacture of galvanised sheet iron.

Experiments are being made in Germany with a wire having a core of aluminium bronze and an outer envelope of a copper bronze. Such a wire is said to have a low resistance and a high tensile strength.

The directors of the Tharsis Sulphur and Copper Company have, out of the net profits for the year, amounting to £246,377, set apart £40,000 to the reduction of mines, piers, railways, and rolling stock account. They have also declared a dividend of 15 per cent. for the year, absorbing £187,500, carrying forward £18,877.

The production of pig iron in the Zollverein, Germany, in January, 1893, was 373,641 tons, as compared with 408,375 tons in January, 1892. The total of 373,641 tons representing the production of January, 1893, was made up as follows:—Puddling and Spiegel pig, 132,111 tons; Bessemer pig, 27,048 tons; Thomas pig, 159,009 tons; and casting pig, 55,473 tons.

New Companies.

CROSTA PATENT NUT SYNDICATE LIMITED.—This company was registered on the 27th ult., with a capital of £1000, in £100 shares, to acquire certain patent and rights now belonging to L. W. Crosta, and for such purpose to enter into an agreement with him and J. A. H. Green, a solicitor of the Supreme Court, and to deal with the rights acquired. The rules of Table A apply with a few exceptions. Registered by S. W. Hutton, 99, Gresham-street, E.C.

FARDELL TRACTION HAULAGE COMPANY LIMITED.—This company was registered on the 23rd ult., with a capital of £750, in £10 shares, to enter into an agreement made between J. R. Fardell and C. E. Fardell, both of Cartwright-street, Minories, E.C., and the company for the purchase of the business of traction haulage contractors carried on by Messrs. Fardell, and the benefit of certain contracts entered into by them. The number of directors is not to be less than 2, nor more than 5, the first being J. R. Fardell and C. E. Fardell. The remuneration of J. R. Fardell as managing director is to be £100 per annum. Registered office, Crescent House, Cartwright-street, Minories, E.C.

E. C. AND J. KEAY LIMITED.—This company was registered on the 25th ult, with a capital of £50,000, in £5 shares, to purchase the businesses and goodwill of the businesses of boiler makers, bridge and roofing contractors manufacturers, hurdle and fencing manufacturers, iron and general merchants, heretofore carried on by E. C. Keay and J. Keay, under the firm of "E. C. and J. Keay," at the Cyclops Ironworks, West Bromwich; the James's Bridge Works, Darlaston, Staffordshire; and at Prince's Chambers, Corporation-street, Birmingham; and to continue the undertaking of boiler makers, etc. The number of directors is not to exceed 7, E. C. and J. Keay being the first; qualification, 50 shares; remuneration, £100 per annum each. Registered by Jordan and Sons, 120, Chancery-lane, W.C. Registered office, Prince's Chambers, 6, Corporation-street, Birmingham.

Official Gazette.

Partnerships Dissolved.

W. PEMBERTON and S. W. PEMBERTON, loom makers and machinists, Burnley, under the style of Pemberton and Co.

W. BROOKES, J. PARKINSON, and D. SWEANEY, wire dealers and wire workers, Salford, under the style of William Brookes and Co.; so far as regards W. Brookes.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Adjudications.

WILLIAM PARKINSON and ANDREW GREAME (trading as Parkinson and Greame), Wharf-road and Manchester-road, Cubitt Town, E., millwrights and engineers.

HENRY LEAROYD, Southall, Middlesex, mechanical engineer.

GEORGE PARTRIDGE, West Bromwich, machinist.

Receiving Orders.

WILLIAM DAVIS HOPE, Chorlton-cum-Hardy, Lancashire, and Manchester, iron and steel merchant.

WILLIAM RAMSEY MARSHALL, South Shields, machinery and metal broker.

Letters to the Editor.

⁂ *We do not hold ourselves responsible for opinions expressed by correspondents.*

⁂ *The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

⁂ *Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

IMPROVED DUPLEX STEAM PUMP.

To the Editor of THE MECHANICAL WORLD.

SIR,—In your issue of March 31 there is a description of an improved duplex steam pump. I write to say that I took out Letters Patent for this particular form of valve gear in the year 1884, No. 15,552, and may add that it is now public property. G. DUNLOP.

London, April 3.

WARSOP AËRO STEAM ENGINE.

To the Editor of THE MECHANICAL WORLD.

SIR,—From a paper read before the Institution of Mechanical Engineers, in 1870, on the above engine, it gave very satisfactory results as regards consumption of fuel.

Can any reader kindly give me any information as to why it has not come into general use, as I am not aware of its being made now?

What I should like to know is, what the effect was of the mixture of air and steam, after continuous working, on the boiler, cylinder, rods, etc.—or any other information. M. R.

St. Petersburg, March 15 (27).

THE AVOIDANCE OF SMOKE.

To the Editor of THE MECHANICAL WORLD.

SIR,—Being part proprietor in a firm where two Lancashire boilers, 24ft. × 7ft., are worked night and day, and which consume on an average 30 tons slack per week, I have been greatly interested in the letters which have appeared from time to time on the above subject.

In perusing the whole of the letters up to date, and in particular the one in your issue of the 24th ult., I find nothing about the efficiency of the 16ft. gas producer as to the horse-power the two boilers worked by it would equal.

I would ask Mr. Nicholson for a little information on this point when he next favours your readers with another contribution. ISRAEL WALKER.

Rotherham.

Miscellaneous Items.

The Brisbane Metropolitan Tramway Company intend to substitute electricity for horse-power, and the Government has extended the time for compulsory purchase by the city.

The total length of railway lines in Europe at the end of last year was 142,658 miles, or 2590 miles more than at the end of 1891, this being equivalent to an increase of 1·85 per cent.

A cement that will stand heat may be made by mixing a handful of quicklime in 4oz. of linseed oil to a good thickness. Next spread on thin plates in the shade, and it will become exceedingly hard, but it may be easily dissolved over the fire and used as ordinary glue.

A syndicate which is engaged conducting coal-boring operations near Ramsey, Isle of Man, has made what is regarded as an important discovery. Near the seashore, at a depth of 60ft., a black substance has been discovered. A sample of it has been sent to London for analysis.

An exhibition of petroleum and the uses of petroleum for heating, lighting, and as motive power, will be held at Bolsward, in the Netherlands, from July 19 to August 11, 1893. English exhibits are invited. Entries close on April 10. Further information may be obtained from the secretary of the Exhibition Committee, Mr. Th. H. van der Meulen, at Bolsward, Holland.

The Swedish Government is contemplating the erection of a manufactory for smokeless powder at the Akers Powder Mills, at an estimated cost of about £12,000.

Pitch-pine beams will shrink in thickness from $18\frac{3}{8}$in. to $18\frac{1}{4}$in.; spruce, from $8\frac{1}{2}$in. to $8\frac{3}{8}$in.; white pine, from 12in. to $11\frac{7}{8}$in.; yellow pine, a trifle less. Cedar beams will shrink from a width of 14in. to $13\frac{1}{4}$in.; elm, from 11in. to $10\frac{3}{4}$in.; and oak from 12in. to $11\frac{3}{8}$in.

A new capstan, worked by electricity, has just been fixed by way of experiment at No. 12 tip, Barry Dock, South Wales. This is the first one of the kind introduced, and is capable of pulling upwards of 50 coal wagons at a time, a feat which totally eclipses any capstan worked by hydraulic machinery. It is expected that the Barry Company will adopt this system at all the tips.

The express locomotive which Messrs. R. and W. Hawthorn and Co., Newcastle-on-Tyne, are sending to the Chicago Exhibition, has four high-pressure cylinders and two pairs of 7ft. 6in. driving wheels, each pair worked by separate cylinders. The trailing wheels are turned by outside cylinders, and the leading wheels by inside cylinders. The weight of the engine is about 60 tons, and the total length from footplate to buffers 32ft. 6in.

An enormous block of cannel coal, from the Wigan Junction Colliery, has been despatched by train to Liverpool for shipment to Chicago. It is said to be the largest block of coal ever dug from the earth, and weighs over 12 tons. In getting it to the surface many men have been employed, and it took nine months to hew it out of the seam. The cost of obtaining it was £1000 — about £83 per ton. When raised it was enclosed in a case of planks, the total weight being 13 tons 11cwt. It was placed on board the steamer "Philadelphian" by means of ropes and chains attached to four pulley purchase-blocks, with a 6in. wire rope span. As a precaution against the masts giving way under the great strain of the lifting gear attached to them, preventive guys were placed fore and aft.

In Belgium the railway companies have just devised a useful plan for the benefit of country visitors and others in the large towns. In Brussels and elsewhere one can now buy goods in any of the shops and have them forwarded direct to any of the railway stations, there to be delivered to the purchaser when starting on his homeward journey. By this means much trouble is saved in either the carrying of parcels or sending them to the hotels, and thence to the station. Books of tickets are issued at a penny apiece to the tradesmen. When buying an article which is to be sent to a station, the purchaser has one of the tickets given to him, and in return for it the goods are delivered to him by the railway luggage clerk, when they can either be taken by hand or registered to their destination.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

ABYSSINIAN PUMP.—Will any reader give me a description of an Abyssinian pump and some information of the same?—T. SMITH.

BRIGHTENING CHAINS.—Can any correspondent inform me what material to use in a shaker to brighten chains?—W. B.

WOOD'S AUTOMATIC PRESSURE RELIEF VALVE.—Required the address of Mr. W. Wood, the maker of the above.—B. AND Co.

COST OF M.S. AND L. RAILWAY.—Can anyone inform me what was the cost per mile of the M.S. and L. Railway from Manchester to Grimsby?—LOW DROP

RAIL CROSSINGS.—Given the gauge and the angle of crossing of rails, what rule is generally adopted to obtain the radius of the curve and the rails?—R. A. J.

LOCOMOTIVE STAY TAPS.—Can any reader furnish me with the addresses of firms who are makers of locomotive stay taps suitable for fireboxes?—GEORGE.

RUST JOINTS.—How can I stop leakage in a vertical joint (rust joint) in my hot-water pipes (low-pressure system) without cutting out the packing? Would any fluid cement percolate into the crevices and harden there?—B.

PUMPING PLANT.—Thanks to Mr. Hopkins for reply regarding pumping plant. Would he kindly say what he thinks would be the cost per day to do the same amount of work with oil engine of, say, best make?—J. P.

POWER RENTAL.—I am desirous of supplying steam power to a tenant from an engine driving his own works. How is the value of such to be ascertained, and what is the fair price for 100I.H.P. per week of 54 hours; also for 8I.H.P. similarly supplied power?

TUBBING.—What system ought to be adopted in the renewal of tubbing in a shaft which has become faulty in the middle of a length of tubbing 25 fathoms from the surface? Pit 15ft. and 100 fathoms deep? Kindly explain what method to use to secure the greatest safety and make the most permanent work.—J. M.

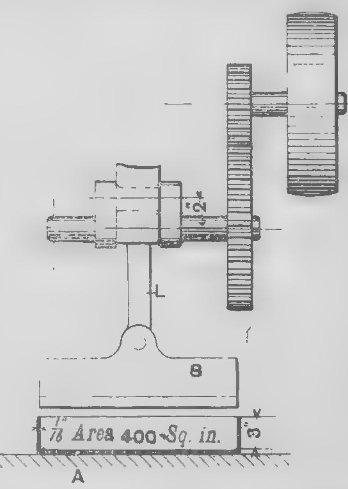
METALLURGICAL FURNACE.—Can any reader furnish me with a scheme for supplying the heating power necessary for a metallurgical laboratory situated in iron-ore mining district, and where no gas is available? A small muffle furnace would be required, in addition to the ordinary heating power, and the fuel used is charcoal. Accommodation only required for one chemist.—H. S.

METALLIC PAPER.—Could any reader inform me how paper can be prepared for taking indicator diagrams upon, with brass or iron point, to give a clear erasure with the slightest pressure?—M. H. M.

COVERING TANK.—I have to cover in a brick water tank 50ft. long, 20ft. wide, with rolled joist and concrete. Will some reader kindly tell me the size of rolled joist required, the distance they should be apart, and the proportion of gravel and cement, and thickness of concrete? It is an open tank, and will have no weight to carry on the top.—S. D.

FACING SLIDE VALVE FACES.—I require a hand appliance, not expensive, suitable for getting up the faces of slide valves of portable, traction, and other engines, say when the valve face is some 3in. to 5in. from the valve-chest cover face. Are there no small hand-lever appliances which can be screwed on to a stud and used for working a broken file or similar tool?—NESCIENCE.

STAMPING PRESS.—I have a press, as in sketch, driven by a 5in. double belt geared 4 to 1 and a connecting link L, which connects the crank to the striker S. The throw of the crank is 2in. What force shall I get in one



blow on the table A, and how shall I calculate the force if a fly-wheel is added, say 3ft. diameter and weighing 300lb? The thickness of the material to be stamped is $\frac{1}{16}$in., the depth about 3in., and the area of stamp 400sq. in.—YOUNG DRAUGHTSMAN.

Replies.

☞ **Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.**

☞ **Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.**

CLOCK JOHN.—Your sketch renders the matter quite clear.

A. WEAVER.—Apply to the Machinery Purchase-Hire Company, 147, Queen Victoria-street, London.

L. M. BALE (Naples).—Messrs. Werner and Pfleiderer, 86, Upper Ground-street, London, will, we think, be able to supply you.

J. H. F.—(1.) You can only case-harden them. (2.) You will find a score of firms in Glasgow if you consult a directory.

VACUUM.—We think you have been misinformed. According to the advertisement on back cover, the work can still be obtained from Messrs. Hopkinson.

"URBS INTACTA."—(1.) The Lancashire boiler is generally conceded to be the more economical generator of the two. (2.) Waring's "Sanitary Engineering," 10s. 6d., and "Heating by Hot Water," by Jones, 2s., will doubtless suit you. They may be had from our office. (3.) Yes; but you do not say what kind of electros you require.

Prize Competition.

WE OFFER FOUR GUINEAS MONTHLY IN PRIZES FOR THE BEST ORIGINAL ARTICLES SENT IN ON ANY MECHANICAL, ENGINEERING OR ELECTRICAL SUBJECT.

IN ORDER THAT MANAGERS, DRAUGHTSMEN, FOREMEN, AND WORKMEN WHO HAVE HAD NO PRACTICE IN WRITING MAY NOT HESITATE TO SEND IN COMPETITIONS, IT IS TO BE UNDERSTOOD THAT ALL ARTICLES WILL BE FULLY EDITED AND CORRECTED, AND JUDGED OF SOLELY ON THEIR MERITS AS ORIGINAL CONTRIBUTIONS FROM A PRACTICAL POINT OF VIEW. THE OBJECT OF THE COMPETITION IS TO INDUCE PRACTICAL MEN TO COME FORWARD AND GIVE THE RESULTS OF THEIR EXPERIENCE.

CONDITIONS.

Competitions for our Monthly Prizes must be sent so as to arrive at the Manchester Offices of THE MECHANICAL WORLD, New Bridge-street, not later than the last Tuesday in each month. Articles arriving after that time will be placed in the following month's competition.

Written competitions must be on one side of the paper only. The contributions must be original, and relate to matters connected with Engineering, Mechanism or Electricity.

The Proprietors of THE MECHANICAL WORLD reserve the right to publish any competition, whether it gains a prize or not.

The competitions may be accompanied by diagrams, sketches or drawings.

Competitors should write the words "Prize Competition" on the envelopes.

Competitors are not confined to one, but may send any number of competitions.

The correct name and address of the sender *must* be distinctly written upon every competition, not necessarily for publication. Competitions can appear under a *nom de plume*.

☞ We cannot undertake to be responsible for any MSS. sent to us, though when stamps are enclosed for the purpose we will endeavour to return rejected contributions.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

20th March, 1893.

5873 Gas Furnace. F J Clinch-Jones.
5878 Reducing Magnetic Disturbances caused by the Electric Currents, etc., of Electric Railways. C V Boys.
5882 Producing Artistic Effects upon Metallic Surfaces. R Kennedy.
5884 Steam Drying Cylinders. J W Gudgeon.
5885 Method of Starting and Stopping Rotary Tipplers for Discharging Coal or other Minerals from "Tubs" or Small Wagons. H T Newbigin.
5887 Automatic Cut-off Gear for Winding Engines. H B Daglish and T Winnus.
5892 Valves. T Bark and others.
5893 Asbestos Steam Packing. J Germain and others.
5894 Blast Elevators for Grain and Granular Substances. T W F Knight.
5907 Forming Joint Connections on Copper Pipes and Fittings. J C Black.
5908 Means for Effecting Circulation of Water in Steam Boilers. A Turnbull.
5909 Flanges and Unions for Steam Pipes and Hydraulic Water Tube Pipes. J Mills.
5911 Electric Contact-maker for Ringing Bells. J R Mann.
5920 Apparatus for Charging Gas Retorts. F Beale and T F Ennis.
5934 Automatic Direct-acting Steam Throttle Valve Controller for Marine Steam Engine. C J Whitcher.
5935 Combined Electric and Compressed Air Motor.* W J Walker and A L Bedford.
5937 Spanners. A Weil.
5944 Electricity Meter. A E Parnacott.
5946 Chuck. A J Howard.
5951 Gas Washers and Scrubbers. J H Fitzgerald.
5952 Machinery for Stamping Ore.* J W Marshall.
5955 Crane Blocks for Suspending "Dogs" or "Grabs."* F W Dick.
5956 Apparatus for Transmitting Ingots or "Blooms" from Vertical Heating Furnaces or "Soaking Pits" and Conveying them to Rolling Mills.* F W Dick.

21st March, 1893.

5959 Steam or other Motive Power Engines. J L Dales.
5963 Combined Lower-water Gauge Cock and Water Gauge Pipe, and Glass-testing Valve for Fixing to Boiler. J Marshall.
5966 Expanding Boring Tools or Drills. C Tennett and W Ambler.
5967 Water Gauges. J H Brown.
5972 Steamships. G Price.
5973 Steam or Pneumatic Engines.* J W Powers.
5974 Rotary Mechanism. S J Williamson.
5978 Safety Valves. F H Rayer and C R Jeyes.
5982 Valves and Valve Chests. J W W Drysdale.
5985 Smokeless Boiler Furnaces.* A B Crowder.
5987 Reducing Electrical Induction on Telephone and other Circuits. G E Fletcher.
5991 Attachment of Wire, Silk, and other Screening Materials to Mechanical Dressers and Sieves. F Stradart.
5996 Recovery of Gold and Silver from Cyanide Solutions. C M Pielsticker.
5999 Slitting or Cutting Steel and Iron Rails and Rolling or Cogging same into Billets. J F Wake and J Cooke.
6000 Electric Fusion of Steel and its Alloys. B H Thwaite.
6001 Appliances for Drying or Conditioning Grain. T A Boynton.
6008 Mode of Working Steam Condensing Engines and Apparatus in Connection therewith. J Murrie.
6022 Ship Propelling Apparatus. C H de Tavernier.
6024 Automatic Safety Reversing Gear for Hoisting or Hauling, applicable to Drawing Water by means of Buckets from Wells or Reservoirs. R, J, and H Wilder.
6031 Transmitting Electric Currents.* B J B Mills (*W Courtenay*, United States.)
6032 Switches for Electric Light Fixtures. B J B Mills. (*J Hutchinson*, United States.)
6033 Light Reflectors. Carello Brothers.
6036 Insulated Conductors.* G J W Jackson.
6038 Wood Screws. J Fry.
6039 Apparatus for Lubricating the Axles of Coal Tubs. J Russell.
6040 Grinding Machine.* D H Church.
6049 Water Meters.* G Westinghouse, jun, and E Ruud.
6050 Alternate Current Motors. O T Bläthy and M Dért.
6051 Manufacture of Illuminating Gas, Artificial Fuel Blocks, etc. G de Velna.
6055 Sectional Moulds for Building and Paving Blocks.* G M Graham.
6058 Railway Signals.* H H Lake. (*S W Miller and others*, United States.)
6059 Puddling Furnaces.* H H Lake. (*J Roberts*, United States.)
6060 Saw Blades. J S Wallace.
6071 Apparatus for Washing and Concentrating Metalliferous Ores, and Extracting Gold and Silver therefrom. R Henderson and A Cruickshank.
6073 Arc Electric Lamps.* J E A Gwynne and R Kennedy.

22nd March, 1893.

6077 Furnaces of Steam Boilers. W Blagborough and J Hardcastle.
6093 Gas and similar Motor Engines. A R Bellamy.
6094 Indicating Water Level in Boilers. J E Slack.
6095 Coating and Covering Ordinary and Steel Wire. S Kellett and others.
6098 Apparatus for Grinding and Polishing Purposes. T Harper.
6103 Twisting or Bending Machine. S W Bannister and C W Hollis.
6104 Nut-forging Machines. C W Hollis and S W Bannister.
6107 Aerial Ship.* J B Howard. (*C F Billwiller*, Switzerland.)
6109 Slotting Machine. C and G B Taylor.
6113 Manufacture of Cotton Ropes. G Worrall.
6117 Nut Blanks. G R Peacock.
6121 Revolving Die Heads for Cutting Screw Threads on Bolts. I Braithwaite and E O'Brien. (*The Dodge Manufacturing Company*, United States.)
6124 Screw-cutting Machines for Rounding Off, Pointing and Screw Threading the Blanks. W P Thompson. (*Franz Weyrer*, Austria.)
6137 Pickling of Metals and Alloys to Remove Oxide and other Impurities. A J Smith.
6139 Coating the Interior of Hollow Vessels by Electro-deposition. A Barrett.
6142 Process of Manufacturing Gas.* W F Richie. (*J B Archer*, United States.)
6154 Machines for Trimming or Bevelling the Edges of Sections of Rolled Iron or Steel. A T Dudgeon and others.

23rd March, 1893.

6170 Apparatus for Forming Earthenware Electric Switches. J Meir.
6177 Galvanised Corrugated Sheets for Roofing. T D Pearson.
6179 Forging Machines. E Tranter.
6180 Tubular Fire Bars. J L Major.
6182 Chains. G W Elliott.
6183 Hydraulic Packings. C Körte and G Heritage.
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6194 Fusible Plugs.* A Turnbull.
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6201 Drawing Compasses. A and L Myers.
6204 Explosive and Pressure, Elastic and Non-elastic, Fluid Turbine Engines.* R C Sayer.
6205 Apparatus for Distributing and Regulating the Distribution of Electricity. R Wood.
6220 Flying Machines.* W P Thompson. (*R Chillingworth*, Germany.)
6224 Steam Condensers. G Zahikian.
6225 Ground Sockets for Tubular Posts for Telegraphic Purposes. Siemens Brothers and Co. Limited.
6227 Joint for Pipes. T J Fife.
6229 High-pressure Taps. M A Brookes.
6232 Pistons. A O Carr and W Lockwood.
6241 Electricity Meters. T Duncan.
6243 Joint for Steam, Water, or Gas. C K Mills. (*Alphonse Costadau*, France.)
6252 Pipe Wrenches. H F Jenks.
6254 Electric Arc Lamps. A L Shepard.
6259 Coal Briquettes. G S Ellis and A M Dolton.

24th March, 1893.

6266 Compass for Drawing Purposes. C H Clark and A Pope.
6293 Apparatus for the Consumption of Smoke in the Furnaces of Steam Boilers. H G Hudson and others.
6295 Electric Incandescent Lamps. T Stober.
6297 Sand Moulding Machines. F G Leeder and W Fairweather.
6298 Securing Valve Seats in Steam Chests or Casings. A Turnbull.
6299 Fuel Economisers and Water Heaters. J Murrie
6300 Portable Tramways. T Robb.
6302 Apparatus for the Extraction of Gold.* E de Pas. (*Louis Clément Daumas*, France.)
6306 Electric Current Meter. S E Nielsen.
6311 Brake Apparatus. W C Dyce.
6319 Wire Ropes.* J T Selby.
6324 Apparatus for the Manufacture of Water Gas.* A G Glasgow.
6337 Water Gauges. H Dunn.

25th March, 1893.

6041 Water Cranes. A Scheid.
6343 Depth-recording Apparatus. A B Nicholetts.
6349 Engaging and Detaching Gear for Ships' Boats. H Bown.
6357 Apparatus for the Automatic Destruction of Vacua in Steam Engine Cylinders after Stopping. R and S Thomas.
6365 Couplings for Pipes. J Alexander.
6366 Steam Traps.* A Turnbull.
6368 Centrifugal Pumps.* A D Ellis and W B Crichton.
6375 Charging and Drawing Gas Retorts. J B Terrace.
6377 Drawing Compasses. W J Harris and W Overton.
6382 Apparatus for the Manufacture of Paper. H Colley.
6385 Joints for Railway Rails.* J Schaefer.
6390 Railway Signal Posts. A G Evans.
6392 Fuel Economiser Apparatus for Heating Water for Steam Boilers. G J Wildridge and J Murrie.

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ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

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FRIDAY, APRIL 14TH, 1893.

Scotch Shipbuilding in March.

THE production of the Scotch shipbuilding yards during the month of March is by no means satisfactory, and the contracts announced are not of a kind calculated to inspire confidence. A new Castle Liner, somewhat similar to the "Dunottar Castle," but slightly longer and faster, is to be built by the Fairfield Company. The Russian Government has placed an order with a Dumbarton firm for a steamer similar to that built last year for the Volunteer Fleet by Messrs. William Denny and Brothers. Messrs. John Reid and Co., Whiteinch, are to build, and Messrs. Kincaid and Co., Greenock, to engine, a small paddle steamer for the Goole and Humber trade. Two sailing vessels of 600 tons are to be constructed by Messrs. Russell and Co. for Messrs. Paterson, Honeyman and Co., of Glasgow and Greenock; and one of larger dimensions by Messrs. A. M'Millan and Son Limited, Dumbarton, for Messrs. Thomson, Dickie and Co., Glasgow. Mr. D. M. Cumming, Blackhill Dock, has been instructed by the Inveraray Town Council to build a small paddle steamer of 40 tons, for passenger service across Loch Fyne. Messrs. W. B. Thompson and Co., Dundee, are to build a steel screw steamer of 1600 tons for the Edinburgh and London Shipping Company. During the month, Scotch shipbuilders launched 26 vessels of 25,269 tons, of which 19, representing 20,489 tons, were steamers; four of 70 tons each barges; and three, measuring 4500 tons, sailing vessels. To the total the Clyde contributed 17 steamers of 19,942 tons, and seven sailing vessels of 4780 tons; the Forth, a steam yacht of 380 tons; and the Dee, a trawler of 167 tons. The Clyde proportion is 24,722, made up of 17 steamers of 19,942 tons, and seven sailing vessels of 4780 tons. To the total yards above Govan contributed 527 tons, Govan 6280, Partick and Whiteinch 3038, Paisley 1087, Clydebank and Dumbarton 8050, Port-Glasgow 3510, and Campbeltown 1230. The total is the lowest since 1889.

Electric Lighting in South Africa.

IT rarely happens that gas or electric-light companies are unable to meet the demands made upon them for artificial illumination. Of course, in the case of the sudden descent of a thick fog, prevailing for say two or three days, or in newly-populated districts, it is not always possible to cope with the demand for light at the commencement. Johannesburg may be classed in the latter category. A concession for lighting this town both by gas and electricity was acquired about a year and a half ago by the Johannesburg Lighting Company, which is an English concern, with offices also in London. The supply of electricity was first commenced in April last year, and of gas in June last. The present company in 1891 bought up the late gas company, which had not started work, and on the arrival of the managing director, Mr. Lance, in December of that year, the only electric plant then erected was a dynamo for running ten arc lamps for street illumination. Mr. Lance states that there is a distinct preference shown locally for the electric light. The electric plant at present erected and in working order comprises the following:—Two 86H.P. Babcock and Wilcox boilers, two 25H.P. (nominal) engines, one 45-unit Elwell-Parker alternator, one 30-unit of the same type, one 10-unit Tyne alternator and a 10-arc light Brush dynamo. In addition to these, there are of course exciters, transformers, and station fittings, and 3½ miles of mains are laid in the streets. This plant is running successfully, and is supplying nearly 2000 lights of 8C.P. with reserve in case of accident. It is noteworthy that the demand for the electric light has hitherto been considerably in excess of what the company has been able to supply, and in order to meet requirements additional plant for 1500 lamps was to be started last month. Not only this, but proposals for further extensions absolutely necessary to keep pace with requirements have been submitted for consideration. The sole rights of lighting neighbouring localities have been acquired. Two remarkable facts are that the coal used, which costs £3 per ton, has to be transported by bullock wagons from Olifant's River, about 70 miles from Johannesburg, and that the price of gas has been reduced from 20s. per thousand cubic feet to 15s. per thousand. It is intended to proceed at once with the extensions in electric lighting, which is, as Mr. Lance states, "undoubtedly the popular light in Johannesburg at the present time."

Workmen's Insurance in Germany.

WE have on previous occasions referred to the system of compulsory insurance of workmen instituted about seven years ago by the German Government. The report of the Central Insurance Bureau, which regulates the working of the entire system, and which has been recently presented to the Reichstag, contains some interesting features in the tabulated results, shown for the first five years of the system, and the deductions drawn therefrom. It appears that at the end of 1890, 64 working-men's associations, organised under the insurance law, and comprising about 5,000,000 of workers, shared in grants and pensions for accidents. Of these perhaps the most important were the associations representing artisans in iron and steel and metal workers generally, which, we find, included 583,000, or 11 per cent. of the whole number of workers. When we come to consider, however, the amounts paid out for accidents, we find that this class absorbed more than 17 per cent. of the total disbursements for accidents in all classes of labour. Further, it is shown that, while the average proportion of individuals in all trades killed or injured while at work during the five years under review was 4·2 in 1000, the proportion in the metal industries was 6 in 1000. These figures clearly prove the fact that workers in metal run far greater risks than those engaged in other industries. When we take the figures for German workmen in the metal industries who have survived after accidents, and have been indemnified or pensioned for them, we find the total number for the first year to have been 1521; in the following year 3363; while in 1890 it had attained the largely increased total of 11,853. When these figures are contemplated, the question whether less care is taken by the insured workmen at once suggests itself. If this is one of the results of compulsory insurance, it is clear that the system cannot be considered a success.

Electric Power.

THERE can be little doubt that when central electric-light stations become more general in this country, and especially in manufacturing districts, a remarkable impetus will be imparted to what is at present only a very limited application of electricity—namely, the use of electric motors for different power purposes. For the moment there are few cases where electric motors are used in engineering shops and manufacturing works generally, but it is noteworthy that in the new works of the Indiarubber, Gutta - percha, and Telegraph Works Company, now rapidly approaching completion, it has been definitely decided to use only electric power. This decision was only resolved upon after very careful consideration. At the great works of Siemens and Halske in Berlin, however, practically the whole of the machines and tools are driven by electric motors, and the same state of affairs prevails in many works in the United States. Of course, it cannot reasonably be expected that large concerns will dispense with their steam plant, introduce electric motors, and obtain, if possible, a supply of current from a central station, or, should one not exist, lay down dynamos and provide their own electric power. Such an innovation might be made on extensions of works where the existing steam plant would be inadequate to cope with the enlargements. For a beginning, however, it seems more in the direction of small works, where machines and tools are operated intermittently, that the benefit of electric power should be most appreciated, where there is a source of obtaining current, as the substitution of electric generating plant for existing steam or gas engines is practically out of the question; but in new works the generating machinery could be laid down both for lighting and power purposes. Naturally enough a decision on the question depends upon more economical working. In order to show what has been done in one case we will gives some figures concerning the working of plant at the new shops of the Northern Railway Company of France, at Saint-Ouen-les-Docks. In these works there are lathes, drilling and planing machines, ventilators, saws, etc., most of which are only used intermittently. Formerly this plant was operated by a gas engine. The average monthly expenses amounted to £16 12s., including the cost of gas and water, cotton waste, repairs and attendance, the daily expense being slightly over 10s. 6d. Now, with an electric motor for driving each tool, the average daily consumption of current during six months has been 11kilowatt hours, supplied by an electrical company at 3⅜d. per kilowatt hour. Thus the cost per day for current is 3s. 5d., and to this must be added the maintenance of motors, oil, attendance, and renewal of brushes, which represent one franc a day. This brings up the total cost daily to 4s. 2½d., or considerably less than half that incurred when the gas engine was used. This may perhaps be an exceptional case, but it is beyond doubt that electric power is more economical than steam or gas under ordinary circumstances.

Continuous Rails.

DURING the last few years the idea of using continuous rails for railways has been revived in the United States, and is at present receiving more than an ordinary amount of attention owing to the very good results which have been obtained. A piece of line, three miles in length, was laid in June, 1889, on a new road ballasted with clayey soil. Three hundred feet of the line is through clay cuttings full of springs; but the only damage incurred has been through settlement, the alignment being practically perfect. During eighteen months the cost of repairs on this section of the line was nothing, while the adjacent three-mile sections each cost about £380, and this part of the line has now been in use for four years. The rails are laid according to Noonan's American patent, with expansion joints at crossings and at the bottom of heavy grades. The rails are butted and connected by two fishplates, ⅜in. thick, with 4in. rivets. At the expansion places the main rails are turned outwardly, but the line is continued by the use of ordinary switch tongues. The rail that is turned aside passes through a kind of clutch held by a spring, and the arrangement is such that the creep of the rail is taken up, whilst the rail is prevented from returning. The track is ballasted level to about half the height of the webs of the rails, which, as is the usual American practice, are of the flanged type, and spiked to the sleepers, the spikes not being driven home by ⅜in. Three-inch drain pipes are put in from 100 to 300ft. apart, to let the water run out from between the rails. The rails have a kind of wavy motion, and are forced forward in front of the engine when a train passes over the line. At first as much as 4in. creep was noticed on some occasions, but now the creep is only a fraction of an inch, although engines of fifty tons have been run over it at fifty miles per hour. What becomes of the expansion and contraction does not seem to be understood, as the rails do not move. It has been suggested that all the expansion is lateral instead of longitudinal, and that instead of longitudinal expansion there is a longitudinal strain set up. The latter idea has been worked out on a mathematical basis, and the non-appearance of expansion ascribed to friction.

Society of Engineers.

AT a meeting of the Society of Engineers, held at the Town Hall, Westminster, on Monday evening, the 10th inst., Mr. William A. McIntosh Valon, J.P., president, in the chair, a paper was read by Mr. H. Conradi on "The Cleaning of Tramway and other Rails."

The author commenced by offering a few remarks with reference to street-cleaning appliances in general, and the conclusion arrived at by him was, that they do not tend to keeping tramway rails clean, but rather the reverse. He then referred to the regulations enforced by some local authorities which compel the tramway companies to leave their lines in the muddy

and dirty condition engendered by the general street traffic unless mud collectors were used in combination with the apparatus for clearing the rails. He pointed out that, although the combination of a mud-collector with an ordinary street-sweeping machine had been condemned and abandoned, several local authorities still imposed this combination as a condition on the tramway companies when using rail-cleaning machines. He also showed how prejudicial to both animal and mechanical traction dirty tram rails were, and described several machines devised for effecting their clearance. These inventions, without exception, were of rigid construction, and therefore incapable of accommodating themselves to the inequalities of the track. They included the patents of Mr. Green, Messrs. J. and E. Townsend, Messrs. Rayner and Edwards, Mr. Dickinson, Messrs. Record and Jordan, Mr. Prosser, and Messrs. Nobes and Jackson. The author then described his rail-cleaning machine, in which the principle of elasticity was introduced for the first time, and was combined with lightness of construction. The first apparatus constructed by him consisted of two tubes, each containing a vertical spring. In each of these main tubes was suspended an internal tube, leaving ample clearance for free play. To each of the inner tubes was fixed a leaf-spring, to which was attached the scraper-point and straight-plate, forming the cleaner. The lifting and lowering gear, carried on a cross-shaft, was worked by a connecting rod and lever from the driver's seat. After a private trial, the apparatus was modified by making the scraper-spring a full coil, by making the scraping-steel and the shovel-plate separate, and the latter of angular shape, and increasing the size of each. Triangular brushes were also added. The author then proceeded to point out the action of the cleaner, which he said was subjected at one and the same time to four constantly varying conditions—viz., deviations and irregularities of the permanent way; lateral deviation of engine or car; vertical motion of engine or car, and the forward motion of the car or engine. The apparatus had been fixed to four tramcars at Reading, and had now been in satisfactory operation for eighteen months, and were still running. He then described several experiments made during the running of the cars, by which it was shown that the tractional resistance met with by a car running on rails cleaned by the previous car was from 25 to 30lb. less than when running on dirty rails. He also compared the cost of various systems of cleaning, arriving at the following results:—By hand, once a day, 1s. per mile of single line in the fine season, and 2s. per mile in the severe season. Watering by cart twice a day, 2s. 6d. per mile. By the author's rail cleaner, as often as required, 6d. per day.

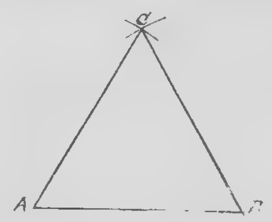
Mechanical and Engineering Drawing.—X.

By a Practical Draughtsman.

Plane Geometrical Figures.—It may be noted, before passing on to the construction of the plane geometrical figures which form the surfaces of the plane solids whose projections we shall next show how to obtain, that as the angles most generally chosen for the surfaces of mechanical details are those which contain some multiple of 5°, it is not necessary to use even a scale of chords in laying them down on paper or other material, as most of them can be obtained by simple geometrical construction, which has fewer chances of error than even measuring from a scale. A few of such angles are 15°, 30°, 45°, 60°, 75°, 120°, 135°, etc., and are thus obtained: For 30°, bisect 60°; for 15°, bisect 30°; for 45°, bisect 90°; for 60°, use radius; for 75°, add 15° to 60°; for 120°, mark off radius twice; for 135°, take 45°, from a semicircle. With these simple constructions committed to memory, and the use of a scale of chords for any angle not easily obtained otherwise, the student will be able to lay down any angle that may be required. We may now proceed with the construction of plane figures, taking first:—

Problem 10 (Fig. 53).—To construct an *equilateral* triangle on a given base? (Note: The *base* of any triangle is that side of it on which it stands; the *vertex*, the point immediately over the base; and the *altitude* the height of the vertex from the base.) With the given base A B as a radius, and from A and B as centres, describe arcs cutting each other in C, the vertex, join A C and B C, and the triangle is constructed. If the altitude only be given as C D (Fig. 54): Then, as the sum of the angles of any triangle are together equal to two right angles, or 180°, and as the triangle required is equiangular, the angle at its vertex will be one-third of 180°, or 60°. To construct it, draw E F, G H through C and D at right angles to C D, and from C, with any convenient radius, describe the arc *a b c*; with the same radius, and from *a* and *c* as centres, cut the arc *a b c* in *d* and *e*, draw lines through C *d* and C *e*, and produce them to meet G H in *g* and *h*, then *g* C *h* is an equilateral triangle having an altitude C D.

Problem 11 (Fig. 55).—To construct an *isosceles* triangle, the base A B and one of the equal sides C D being given? With C D as a radius, and from A and B as centres, draw arcs intersecting in *a*, join *a* A and *a* B, and the triangle is constructed. If the base A B and the altitude *a b* are given (Fig. 56): Bisect the base A B in *b*, and at *b* erect a perpendicular and make it



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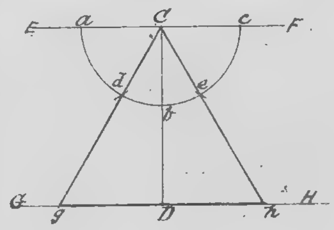

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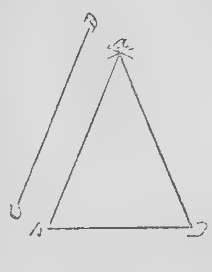

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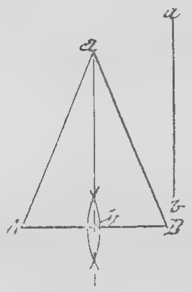

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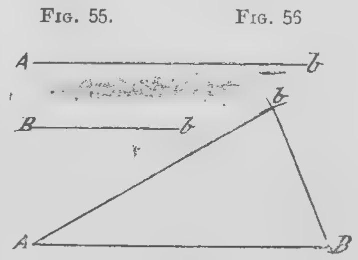


Fig. 57.

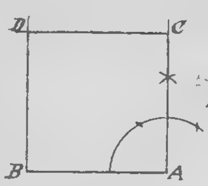


Fig. 58.

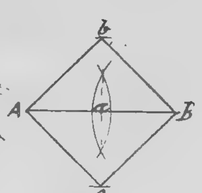


Fig. 59.

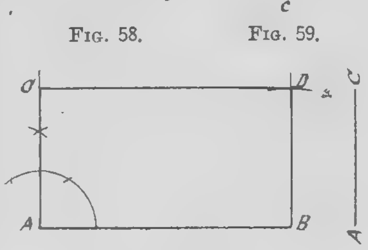


Fig. 60.

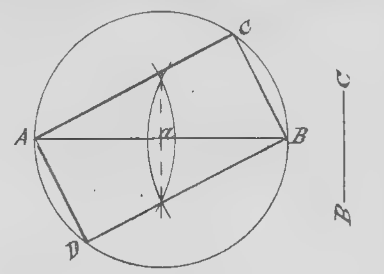
equal to *a b*, join *a* A and *a* B, then A *a* B is the required isosceles triangle

Problem 12 (Fig. 57).—To construct a *scalene* triangle, the sides being given? Take the longest side A B for the base, and with the shortest as a radius, and from B as a centre, describe an arc; then with the length of the third side as radius, and from A as centre, cut the arc described from B in *b*, join *b* and A, and *b* and B, then A *b* B is the required triangle.

Problem 13 (Fig. 58).—To construct a *square* on a given line A B as a side? Erect at A a perpendicular to A B, and from it cut off A C equal to A B; then from C and B as centres, and with A B as radius, draw arcs intersecting at D, join C and D and B and D, and the square is constructed. If the given line be a diagonal and not a side: Bisect the diagonal A B (Fig 59) in *a*, by a perpendicular *b*, *a*, *c*, and from *a* set off *a b*, *a c*, equal to *a* A, or *a* B, join A *b*, *b* B, B *c*, *c* A, and the square is constructed on the given diagonal A B.

Problem 14 (Fig. 60).—To construct a *rectangle*, the length of two adjacent sides being given. Let the line A B be one of those sides. At A erect a perpendicular to A B, and cut off from it in C, a length equal to the other given side; from B as centre, and with a radius equal to A C, draw an arc, and from C as centre, with a radius equal to A B, draw another intersecting the first in D, join C D and D B, and the required rectangle is constructed.

Problem 15 (Fig. 61).—To construct a *rectangle*, a diagonal A B and one side B C being given? As the *diagonal* of a rectangle divides it into two right-angled triangles, if it is made a diameter, and on it a circle is described, the circle will contain the two right-angled triangles which



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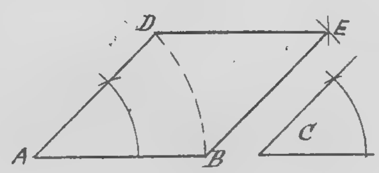

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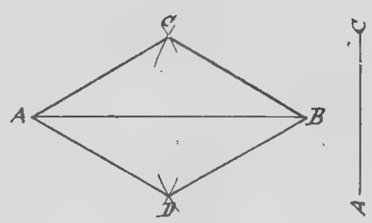

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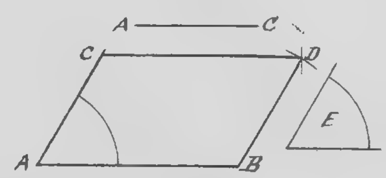

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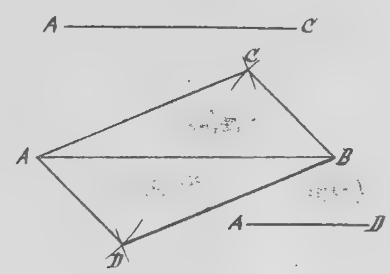

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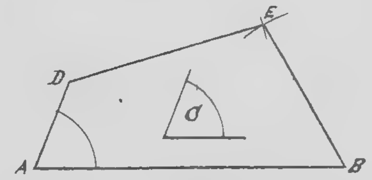


Fig. 66.

will form the rectangle sought. Therefore, bisect the given diagonal A B in *a*, and from *a*, with *a* B as radius, describe the circle A B C D; from B as a centre, and with B C as radius, cut the circle in C, and from A, with the same radius, cut it in D, join A C B D, and it is the required rectangle.

Problem 16 (Fig. 62).—To construct a *rhombus*, one of a pair of opposite angles and length of a side being given? Let A B be the length of given side, and C the given angle; at A make the angle B A D equal to angle C, and the side A D equal to A B; from B and D as centres, with A B as radius, draw arcs intersecting in E; join E B and E D, and A D E B will be the required rhombus. If a diagonal A B and length of a side A C be given (Fig. 63): Then, if from A and B as centres, with a radius equal to A C, arcs be struck cutting each other in C, and D, and lines be drawn joining A and B to C and D, the figure A C B D will be the required rhombus.

Problem 17 (Fig. 64).—To construct a *rhomboid*, the lengths of two adjacent sides and one of a pair of its opposite angles being given? Let A B be one (the longest) of the adjacent sides, and E one of the opposite angles. At A make the angle C A B equal to the angle E, and cut off A C equal to the shorter adjacent side. From C, with A B as radius, describe an arc, and from B, with A C as radius, describe another cutting the first in D, join A C D B, and it is the required rhomboid. If a diagonal A B (Fig. 65) and the lengths of two adjacent sides be given: Then, with the length of one of those sides as a radius, and from A and B as centres, describe arcs on *opposite* sides of A B, and from the same centres, with the length of the other adjacent side as radius, describe arcs cutting those first drawn in C and D, join A C, C B, B D, D A, and it will be the required rhomboid.

Problem 18 (Fig. 66).—To construct a *trapezium*, the length of its sides and one of its angles being given? Let A B be the *base* of the figure or side on which it stands, and C the given angle. At A in A B make D A B equal to the angle C, and let A D equal the length of that side of the figure; with the length of the opposite side as radius, and from B as centre, describe an arc, and from D as centre, with the length of the fourth side as radius, strike an arc cutting the last in E, join A D E B, and the required trapezium is constructed.

(*To be continued.*)

Engineering Pattern Making. XXIX.

By a Foreman.

Worm wheels are used in conjunction with worm or tangent screws working at right angles and transmitting motion with the greatest reduction of speed. This is owing to the worm having to make a complete revolution before the wheel is moved a distance either forwards or backwards equal to the pitch, the worm thus representing, as it were, a pinion with a single tooth.

Worm wheels are of two kinds, the first having a straight face, the second a concave one with a radius at the *top* of the teeth equal to that of the worm at the *bottom* of the thread. The latter are generally known as *hollow face* wheels, and the object of the concave face is to give a greater working surface by enveloping the circumference of the worm, as shown at Fig. 179. By reference to the following Fig. 180, it will be seen that a wheel with a straight face will only be in contact with the worm at a point directly on the centre line. The teeth in each case are set at the *same* angle, corresponding to that of the *hypothenuse* of a right-angled triangle, the *base* of which equals the *pitch* of the screw or worm, and the *perpendicular* the circumference at the pitch line. A *straight-face* wheel occupies much less time in both pattern making and moulding, as it admits of being moulded in an ordinary box, whilst the *hollow face* necessitates the use of a three-part box and the making of the pattern in halves through the centre A B (Fig. 181).

A worm wheel having a straight face must not be confounded with a helical wheel, and though in both cases the teeth are in a diagonal direction on the face, the angle of the teeth on the worm wheel is governed by the diameter of the worm with which it works, while the true helical may be described as a section of a worm having a number of threads, each one of which represents a tooth. If the number of threads or teeth are so disposed as to be at an angle of 45° they are known as skew wheels, and may be used in place of mitres. Although a definition of the several kinds of wheels has been given, it is not unfair to assume that the designation of the various points in a wheel are not always clearly understood, though frequently used; consequently we propose to refer to them in order that no ambiguity may exist when these terms are employed to illustrate the construction of the patterns. The most important part of a wheel is the teeth, the several proportions of which are measured from the "pitch line"—*i.e.*, a line passing through the teeth on the edge of the wheel at such a distance from the centre that the circumference of the line, if not interrupted by the spaces between the teeth, would represent a length equal to a straight line containing as many points equidistant from one another. When this line is referred to in connection with a tooth it is called the "pitch line," but becomes the "pitch circle" when the entire wheel is being considered. The diameter of the "pitch circle" is obtained by multiplying the number of teeth by the "pitch," and that product by 0·31831,

which gives the diameter in inches and decimal fractions; twice the height from this line to the top of the tooth being added thereto gives the extreme diameter over the points of the teeth. From this line, which we may call the primary one, all other dimensions relative to the teeth are usually taken, except in the case of wheels having a "diametral" pitch instead of a circular

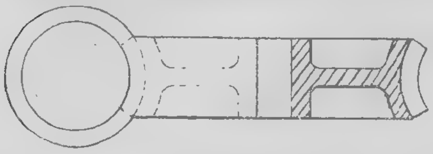


FIG. 179.

one. By referring to Fig. 182 the several proportions will be readily understood, and any wheel set out from the given formula. In using the word "pitch," or distance from tooth to tooth, we have taken the one generally accepted—that is, the "chord pitch," or distance measured on a straight line as shown at Fig. 183,—though some conflict of opinion has taken place among

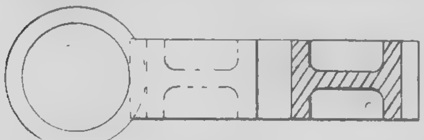


FIG. 180.

acknowledged authorities as to which is the more correct, the length of the chord from the centre of one tooth to the centre of another, or the length of the arc between these points. Practical experience, however, points to the chord in preference to the arc measurement, as the latter, if

FIG. 181.

adopted, would involve considerable calculation, which at times would be inconvenient. Consequently, the chord pitch is the one generally agreed upon, though exception may be taken to this in particular cases, on account of difference in the length of the chord when a wheel of coarse pitch and fewer teeth is taken, as the diameters of a pair of wheels of 80 T

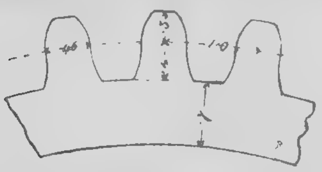


FIG. 182.

and 20 T, 3in. pitch, would not be exactly proportioned to each other. This difficulty we can overcome by using the table of natural sines as a corrective method against the ordinary one, and by giving

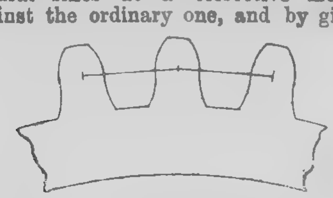


FIG. 183.

examples showing the working out of the data the difference will at once be apparent.

Diametral pitch has been mentioned, and though very seldom made use of in the pattern shop it is quite necessary that we should explain its meaning. When a wheel contains a certain number of teeth to a given diameter, and the pitch of which

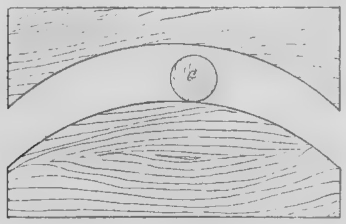
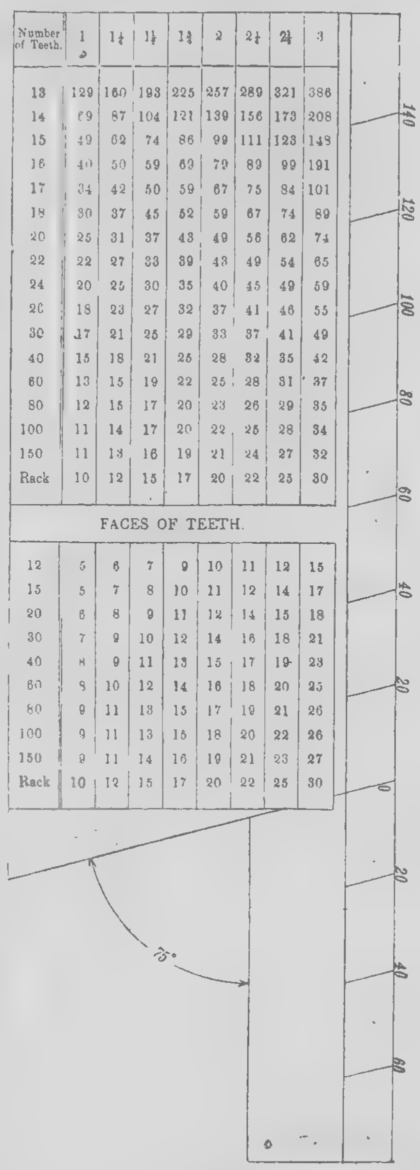


FIG. 183a.

cannot be exactly measured on the arc or chord of the circle, it then becomes a "broken pitch," or one that does not represent any of the graduations of the standard rule. Such a wheel is known as a 4, 6, 8, 10 or 12 pitch, each of these figures representing the number of teeth on each inch of the diameter; thus a wheel of 8 pitch and 8½in. diameter will have 64 teeth, and one 5½ diameter and 10 pitch will contain 50 teeth, the fractions of ½ and ½ over the whole numbers being the allowance equal to two more teeth to form, as it were, the height from the pitch line to top of tooth. Thus to obtain the extreme diameter for wheels on this principle it is necessary to add *two* teeth extra to the number required and divide by the numerical pitch; the quotient is the diameter over all. As this system is one generally used



FLANKS.—PITCH IN INCHES.

Number of Teeth.	1	1¼	1½	1¾	2	2¼	2½	3
13	129	160	193	225	257	289	321	386
14	69	87	104	121	139	156	173	208
15	49	62	74	86	99	111	123	148
16	40	50	59	69	79	89	99	191
17	34	42	50	59	67	75	84	101
18	30	37	45	52	59	67	74	89
20	25	31	37	43	49	56	62	74
22	22	27	33	39	43	49	54	65
24	20	25	30	35	40	45	49	59
26	18	23	27	32	37	41	46	55
30	17	21	25	29	33	37	41	49
40	15	18	21	25	28	32	35	42
60	13	15	19	22	25	28	31	37
80	12	15	17	20	23	26	29	35
100	11	14	17	20	22	25	28	34
150	11	13	16	19	21	24	27	32
Rack	10	12	15	17	20	22	25	30

FACES OF TEETH.

12	5	6	7	9	10	11	12	15
15	5	7	8	10	11	12	14	17
20	6	8	9	11	12	14	15	18
30	7	9	10	12	14	16	18	21
40	8	9	11	13	15	17	19	23
60	9	10	12	14	16	18	20	25
80	9	11	13	15	17	19	21	26
100	9	11	13	15	18	20	22	26
150	9	11	14	16	19	21	23	27
Rack	10	12	15	17	20	22	25	30

FIG. 184.

for machine-cut wheels, the pattern maker has little to do with them beyond the preparation of the patterns for the cast-iron blanks, making allowance for contraction and turning up of the metal blanks to size before cutting.

The different forms and the methods of setting out the *teeth* of wheels is the next and most important consideration, as each form claims superiority under certain conditions. The most common shape of tooth is that of the epicycloidal or double curve formed by the rolling of a thin disc of metal or wood alternately on the *outside* and the *inside* of a circle corresponding in diameter to the *pitch* circle of the wheel. The two curves produced represent the correct form of the top and bottom of the tooth, and wheels set out by this method have an advantage, as they will gear with one another irrespective of diameter. In Fig. 183*a* is shown a practical method of setting out the curves, such as should be adopted in a workshop. Two pieces of timber about ½in. thick are cut out, the one concave, the other convex; the internal radius of the one and the external radius of the other being the radius of the pitch circle of the wheel. The thin disc of wood or metal G (Fig. 183*a*) previously referred to is termed the generating or rolling circle, and the best practical results have decided in favour of its *diameter* being equal to the *radius* of a wheel with 15 teeth of the same pitch as that for which the tooth is to be described, or the pitch of the wheel may be multiplied by 2·38; thus, the generating circle for wheels of 1in. pitch would be 2·38, and similarly for those of 2in. pitch 4·76in. diameter. The different proportions of the teeth are given at Fig. 182, and the thickness of the tooth at the pitch line having been taken, the radius of the pitch circle is then struck on a board, and the thickness of the tooth as calculated transferred to the board. Upon the pitch circle, by means of a pair of dividers, the templet with the concave edge should then be fastened with a couple of fine screws, and the generating circle may have a very slight notch on its edge, so that a fine-pointed pencil, which should be held against it, is prevented from slipping while being rotated to form the root or flank of the tooth. This operation is performed conversely from each of the points marked by the dividers on the pitch circle. This completes the tooth from the pitch line to the flank. The convex templet is then fixed in position, and by the rotation of the disc the curve forming the top of the tooth is described. These curves may be closely approached by dividers or compasses, and transferred to the pattern when setting out for cutting, the exact position of the centres of the radii being noted, and a fine line or lines put round the edge of the teeth concentric with the pitch circle, and from which the radii of each tooth is to be struck. Some years ago an instrument named the odontograph, the invention of Professor Willis, of Cambridge, was introduced for the purpose of setting out double curve teeth without the

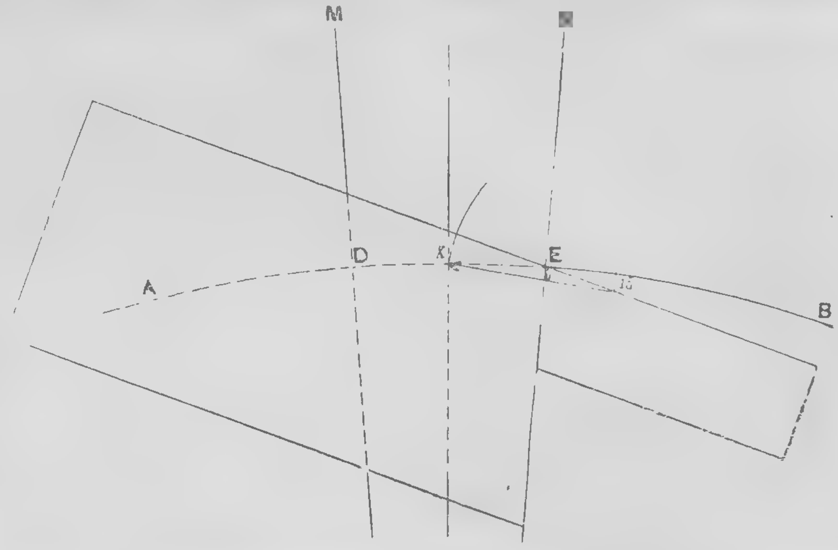


FIG. 186.

trouble of templet making or generating discs. It consists of a thin plate of metal, a plan of which is shown at Fig. 184. The edge is marked in inches, and these divided into twentieths, the graduations

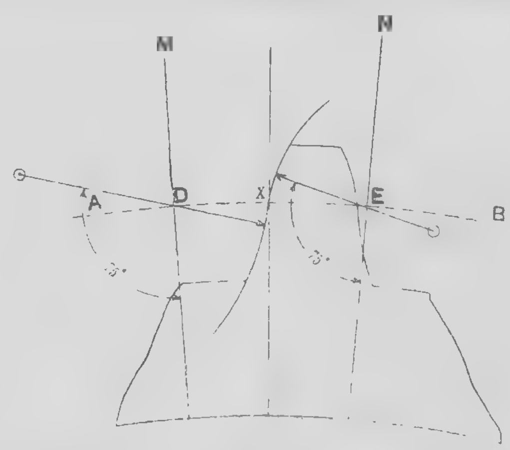


FIG. 187.

starting right and left from a line drawn across the width of the plate at an angle of 75°, the division lines also being drawn parallel to this angle. The method of application is shown at Fig. 185, and represents the odontograph in position to determine the centre of the radius for the flank of a tooth for a wheel of 40T., 2in. *p.* Similarly Fig. 186 shows the instrument in position for the point of the tooth, and

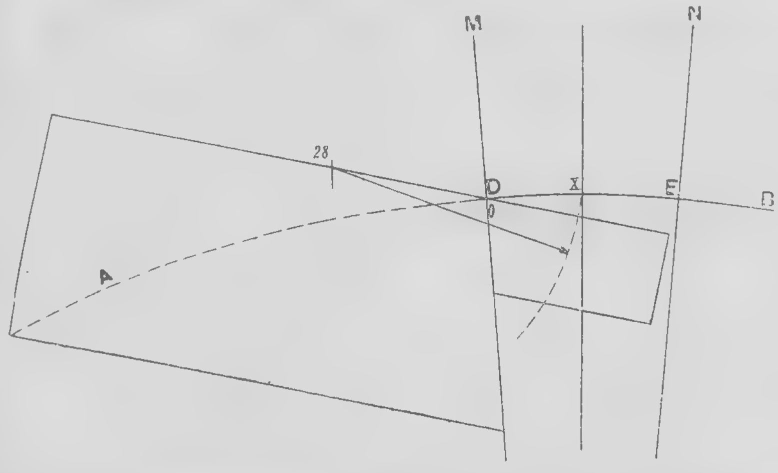


FIG. 185.

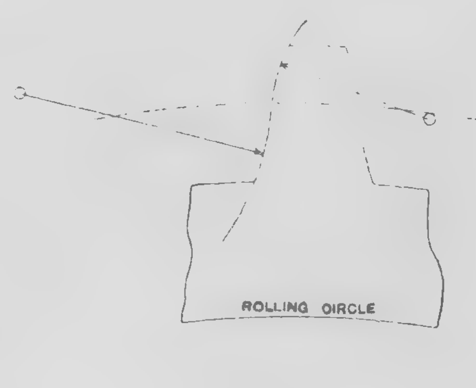


FIG. 188.

by reference to the figures its use will be understood, though it may, perhaps, be more clearly described as follows:—About a centre representing that of the wheel, an arc A B is described of the same radius as the pitch circle, and upon this line is set out the pitch of the wheel D E. From these points the lines M N are drawn to the centre, and produced beyond the pitch line. The distance D E is bisected on the line A B, this point X representing the convergence of the double curve forming one side of the tooth; from this point X the thickness of the tooth is marked upon A B. The line O, or zero, which crosses the instrument, is then placed on the line M with the graduated edge touching the pitch

line. Then, by reference to the scale, it will be seen that No. 28 on the *left* hand of the odontograph is the one given for 40 T., 2in. pitch, and at this point a mark or centre should be made in which one leg of a pair of dividers or pitch compasses should be inserted, the other leg touching the point X on line A B, a distance of 2·625in.; with this as a radius the flank of the tooth is described. For the point of the tooth, O or zero on the instrument is set on the line N and touching the pitch line, the number 15 on the scale to the *right* hand being the centre, with radius touching point X equal to 1·75in. The shape of one side of the tooth having been formed, it remains for the centres of the radii to be fixed for the opposite side, and for this purpose lines, as those for the rolling circle, are required. Similarly teeth, whether *long or short*, can be accurately formed by either of the methods, the length of the tooth having no effect on the working surface, the same curves or radii holding good for any length of tooth. In the examples shown at Figs. 187 and 188 the same number of teeth and the same pitch have been taken, so that the difference of the curves in the two methods may be discerned. Several other scales are in existence with little deviation, though sufficient to make an appreciable difference in the shape of a tooth set out from their particular data, but the two given are those generally adopted and prove to give the best results.

(To be continued.)

On Belting for Machinery.

(*Continued from page* 137.)

I HAVE made a small collection of samples of belting sold in the Glasgow market, and with these I have made a series of experiments with a view to ascertaining the friction factor of the belts when they are new and untouched by any oil or dressing.

It is to be clearly understood that these tests are not for the purpose, nor can they serve the purpose, of determining the relative merits of these belts. They must be taken as a whole to indicate, collectively, one of the properties of belting *per se*. A set of comparative trials would have to be much more extended, and conducted with more accuracy than I have thought necessary for my present purpose.

Appended to this paper are tables showing the results of these trials, and of tests of tensile strength.

The friction trials were made by suspending a 7ft. length of 4in. belting of each of the makes described over a flat-faced pulley 9½in. diameter by 4½in. face suspending weights at T_1 and T_2, and adjusting them so that the belt was just on the point of slipping over the pulley but remained fast.

with oil we may find a friction factor of 0·00 taking possession of the surfaces; and those of us who have to face enthusiastic crowds waiting the fulfilment of the promise of the coming of the electric light, had better face the worst, and while taking precautions to keep oil off our belts, assume a friction factor of 0·15 for new belts, and take out our margin between that and a possible 0·42 in a longer and easier life for the belt.

Having determined the coefficient of friction, and using Rankine's formulæ, it is easy to find the tension which must be given to the belt to produce the resistance necessary to transmit the required power.

Example.—Power required, 10H.P. = 33,000 foot-pounds per minute × 10. Revolutions of pulley, 1000. Diameter of pulley, 12in.

$$\text{Arc of contact, } \theta = \pi = \frac{n}{2} = 0{\cdot}5.$$

$$T_1 - T_2 = R = \frac{33{,}000 \times 10}{1000 \times 3{\cdot}14159} = 105\text{lb.}$$

$$\log. \frac{T_1}{T_2} = 2{\cdot}7288 \times 0{\cdot}15 \times 0{\cdot}5 = 0{\cdot}20466.$$

$$\therefore \frac{T_1}{T_2} = 1{\cdot}602 = e^{f\theta}$$

$$\frac{T_1 + T_2}{2R} = \frac{e^{f\theta} + 1}{2(c^{f\theta} - 1)};$$

$$T_1 + T_2 = 2R\left\{\frac{e^{f\theta} + 1}{2(e^{f\theta} - 1)}\right\}$$

$$= 2 \times 105\left\{\frac{1\,6 + 1}{3{\cdot}2 - 2}\right\} = 453.$$

$$T_1 - T_2 = 105.$$

$$\therefore T_1 = 279;\ T_2 = 174.$$

Although I here use the formulæ as given by Rankine, I am sorry to say that I am unable to recommend their acceptance with that faith which mathematicians claim for their mystic symbols. These formulæ proceed on the assumption of perfect flexibility, the calculation proceeding by integration of resultant pressures on infinitely small elements of the arc of contact. There is a possibility that the speed of running the belt may affect the accuracy of the assumption of perfect flexibility. A belt which may be assumed to be perfectly flexible for the purposes of an experiment, made with the surfaces at rest and when there is time for the two surfaces to come intimately in contact, may when run at a high velocity, and bent and unbent rapidly as it runs, be less completely in contact with the pulley, and this may, along with differences introduced by rise in temperature, produced by the rubbing of the two surfaces slipping relatively to one another, help to account for the differences in the coefficient of friction which have been

TABLE I.—TESTS FOR BREAKING STRAIN. | TABLE II

	Size of Sample—in. Length.	Breadth.	Thickness.	Area.	Breaking Strain. Actual. Tons.	Per sq. in. Tons.	Extension. Ultimate per cent.	Per 1cwt. per cent.*	Weight per ft. in lb.	W'g't per ft. Breaking strain per sq. in.	Breaking strain per inch width in lb.	Friction. Factor.	No. of experiments of which mean is taken.
Gandy cotton	18·5	2·04	0·18	0·367	1·6	4·35	9	3·1	0·161	0·037	1740	0·35	2
Do. spliced	17	2·04	—	—	0·4	—	—	—	—	—	425	—	—
Hendry edge leather	18·375	1·96	0·28	0·549	1·0	1·82	3	0·78	0·245	0·134	1140	0·132	3
Do. spliced	18·625	2·0	0·27	0·54	0·7	1·29	5	—	—	—	785	—	—
Gandy leather	18·375	2·0	0·21	0·42	0·85	2·04	4	3·15	0·183	0·09	940	0·22	2
Do. spliced	18·3	1·94	0·18	0·35	0·6	17	—	—	—	—	691	—	—
Dick's gutta-percha, 3 ply	18	1·96	0·14	0·274	1·1	4·0	6	0·78	0·104	0·026	1250	—	—
Do. 4 ply	18·2	1·97	0·17	0·335	1·55	4·62	7·5	1·57	0·126	0·027	1780	0·168	1
Tullis link	18·25	2·0	0·54	1·12	0·5	0·45	4	—	1·14	2·52	560	0·136	6
Hoyt's oak-tanned	18	1·95	0·27	0·526	1·2	2·28	8	—	0·166	0·077	1344	—	—
Do. with joint	18	2·0	0·18	0·36	0·95	2·65	4	2·35	—	—	1050	—	—
Hoyt's oak-tanned, split —grain portion	18	1·95	0·12	0·234	0·35	1·49	3	3·0	0·083	0·0555	850	0·149	1
Hoyt's oak-tanned, split —flesh portion	18	1·95	0·12	0·234	0·4	1·7	3	3·0	0·033	0·049		0·166	1
Tullis orange tan	—	—	—	—	—	—	—	—	—	—	—	0·151	5
MacLellan's rubber	18·25	2·12	0·27	0·572	1·1	1·92	2	—	0·33	0·172	1140	0·32	2

* The readings for extension with strain of 1cwt. are not accurate, as the testing machine index is too difficult to read at so low a value for the strain.

The difference $R = T_1 - T_2$ was taken in many of the experiments at about the working strain used by the author for the size of belt tested.

The average coefficient of friction for new dry leather belts as deduced from these experiments is 0·153.

The coefficient given by Rankine in the article referred to is 0·42, which he says we may safely take in designing machinery, that 0·22 is ordinary practice, but that 0·15 is to be taken if there is a possibility of the belt becoming wet with oil.

With the most profound deference to this illustrious author, if a belt becomes wet shown to exist in the American experiments referred to.

The errors arising from these causes are not, however, fatal. We shall see later on, when we come to speak of the strength of belting, that a first approximation arrived at by the method which we have adopted will be sufficiently accurate for practical purposes, and that if any slipping takes place in a belt transmission designed on this basis we have plenty of margin in the strength of the belt to permit of an increase in the tension so as to get the resistance required.

It will be found as a general rule that the assumption of so low a friction coefficient will ensure a satisfactory result.

Having then determined the tension in the driving and following sides of the belt, we have to use this result in determining the size of band necessary to transmit the required power. Table I. gives the results of tests on the breaking strain of belting. The samples were chosen from the classes of belting most used in this neighbourhood, and the results are very much better than those given in the records of older tests, showing a distinct improvement in the manufacture. The leather samples were all of single belting, and all the samples were approximately 2in. wide.

My experience in the use of belts is practically limited to leather, having found any attempt to use any other kind of belt uniformly unsatisfactory from various causes, chief among which are the troublesome liability to stretch, which is a property of belting made of textile material, and the liability to uncertain wear, which is found in belts which are not homogeneous in structure.

The following remarks are therefore confined to the consideration of leather belts:—The strength of the belt is, of course, the strength of its weakest part, and this is generally the joint. We are safe to reckon that Nature and the tanner will make the body of the belt substance stronger than the most skilful and experienced jointer can make a joint in it. The breaking strain on a good joint in a single leather belt may be taken as 842lb. per inch of width.

Referring back to our example, it would appear that the maximum strain on a belt transmitting 10H.P. under the conditions given would be 279lb., so that it would appear that if a single belt was worked up to the breaking point of its weakest part, it would transmit nearly 30H.P. per inch width under the given conditions, and running 1000 × π feet per minute. Here, however, come in very important limitations. The stretch in a belt under such a strain would be instantaneous and fatal to its stopping on the pulley at all. It is evident that the ultimate strength of the belt, taken by itself, is no guide to the power which may be transmitted by it. Under the title Factor of Safety, many figures, varying as much as usual, have been confidently stated as the proper ratio between the ultimate strength of the belt and its working strain $\frac{10}{1}$, $\frac{12}{1}$, $\frac{15}{1}$, $\frac{20}{1}$, etc., etc. The fact, however, may be stated broadly, that the ultimate strength of the belt, while an important element in the question, is so much less important than other elements that it may be left out of consideration in the assurance that there is no leather belt in the market which is not strong enough to stand any strain which can be put upon it in ordinary working conditions, this strain being limited by other conditions than the ultimate strength of the belt, to a point far below the breaking strain.

Another element in the question may be dismissed here in a few words as being usually so small as to be negligable—viz., the increase in strain due to centrifugal force.

The weight of the belt itself (determined again by considerations entirely overshadowing the question of centrifugal force) is so small in relation to the pull which it has to transmit, that we only mention the method by which the curious in these matters calculate this quantity. The method will be found in "Rankine's Machinery and Millwork," page 441, and is "$\frac{w\,S\,v^2}{g}$, in which w is the heaviness (being for leather belts nearly equal to that of water); S, the sectional area; v, the velocity; and g, gravity = 32·2ft. per second."

The really important elements in determining what power a given belt will transmit are not expressible in figures, and can only be determined by trial of the belt in the conditions under which it is to work. If, however, we determine these for a belt made by a manufacturer of good standing, in whom we may place implicit confidence, we may safely base our calculations on experience with one or two samples of any width. Further, a knowledge of what these important elements are will enable us to select these samples with some prospect of satisfactory results.

The selection of hides and of portions of hides for belting is a business to which greater attention was paid for many years in America than in this country, but that pre-eminence is less marked now than it was ten years ago. Further, various mechanical and structural devices have been resorted to to attain the desired results with materials which cost less than the particular kind of leather required to make first-class belting by the original simple methods.

The first essential in a belt which is to transmit power is that it *shall keep on the pulleys*. That it may do so it must be straight to begin with, it must keep straight, and it must run straight.

2nd. It must have *little longitudinal stretch*, so that it will "keep up to its work."

3rd. It must be flexible, so that it will bend sweetly and easily over the pulleys with little loss of power, and that it will lie closely to the surfaces of the pulleys and offer resistance to relative motion of the surfaces.

4th. It must be uniform in thickness, so that it will not vary in its properties of flexibility throughout its length, and thus produce irregularity of motion.

5th. It must be thin, so as to absorb little power in bending over the pulleys, and have small relative motion between its outer and inner surfaces, as such motion not only absorbs power by internal friction, and causes "creepage" (the caterpillar-like motion caused by the elasticity of the leather as the tension changes from the driving to the driven side), and consequent loss of power, but rapidly destroys the fibre of the belt.

6th. It should be homogeneous in its structure, so that the strains may be equally distributed throughout its substances in all three directions. It should therefore be single wherever possible.

7th. Which is really included in sixth. All stitching, lacing, or riveting in a leather belt is a source of weakness, reducing its ultimate strength by the holes. Therefore all joints should be *cemented only*. A good cement joint is stronger than any other, and disturbs the natural structure of the belt less than any other. All clamps, fasteners, etc., are bad. The best fastening for a belt when the proper working tension has not been determined, and a temporary fastening is required, is the laced butt joint, which should be removed and replaced by a cemented lapped joint as soon as possible.

It will be difficult, of course, to apply all these requirements to each individual case, but all are of great importance, and the efficiency of a drive will depend on how far they have been adhered to in their entirety.

(To be continued.)

Shipbuilding Notes.

The "Campania" went on an official trial trip on the 6th inst., in the Firth of Clyde. With a steam pressure of 155lb. per square inch she easily maintained during six hours a speed of over 23 knots.

Messrs. Scott and Co., Greenock, have contracted to build for a French firm a steel paddle steamer for river service in Senegal. Her length will be 145ft.; breadth, 22ft.; and depth, 7½ft. The builders will supply engines of 350H.P.

On the 6th inst. Messrs. Day, Summers and Co., of the Northern Ironworks, Southampton, launched a new paddle steamer named the "Lymington," which they have built to the order of the London and South-Western Railway Company.

On the 6th inst. a screw steamer was launched from the shipbuilding yard of Messrs. Scott and Sons, of Bowling. The dimensions are:—175ft. by 26ft. 6in. by 13ft. Triple-expansion engines will be supplied by Messrs. Muir and Houston, Glasgow.

There was launched on the 5th inst., from the yard of Messrs. Murdoch and Murray, Port-Glasgow, a steel screw steamer of the following dimensions, viz.:—142ft. by 23ft. 6in. by 10ft. 6in. moulded. She will be fitted with powerful engines to maintain a speed of 12 knots.

Messrs. Barclay, Curle and Co. Limited launched, on the 7th inst., from their shipbuilding yard at Whiteinch, a paddle steamer, built to the order of the Brighton, Worthing and South Coast Steamboat Company Limited, Brighton. Her dimensions are:—160ft. by 21ft. 6in. by 8ft. 9in. The engines, supplied by the builders, are compound surface condensing, and fitted with all the latest improvements.

On the 5th inst. there was launched from the Cleveland dockyard of Sir Raylton Dixon and Co., Middlesbrough, a steel screw steamer. Her dimensions are:—Length, 313ft.; beam, 41ft. 2in.; depth, moulded, 21ft.; and she has a deadweight carrying capacity of over 3500 tons. Engines will be fitted by Mr. John Dickinson, of Sunderland, the cylinders being 23in., 37in., and 60in. diameter by 42in. stroke, with large boilers working at a pressure of 160lb.

The Campbeltown Shipbuilding Company's screw steamer "Vanland," of 772 tons net register, and 1950 tons deadweight, recently launched from their yard at Campbeltown, made her trial trip on the 6th inst., when an average speed of 11½ knots was attained, with 300 tons on board. She is a steel screw steamer designed to carry 1950 tons deadweight on 16ft. 17in. draft, and has been supplied with a set of triple-expansion engines by Messrs. Kincaid and Co. Limited, engineers, Greenock.

Compound Expansion Engines.

(*Concluded from page* 138.)

THESE last results are, of course, hypothetical to the extent that they are based upon the assumed condition that the steam would impart and absorb heat as rapidly as the cast iron of cylinder, due to its degree of conductivity, the object being to ascertain the maximum possibilities of effect, in quantity and degree of heat, with reference to the cylinder only.

This correction, however, will have no effect on the application of the results, as we shall see that the actual interchange of heat must be very far below the ascertained capacity of the iron cylinder; and the limit of effect, therefore, will be that due to the thermal properties of the volume of steam. We have in the 480 cub. in. $\frac{480}{1728} = 0{\cdot}27273$ cub. ft. The relative volume at 125lb. is 219·6, and the weight per cub. ft. $\frac{62{\cdot}41}{219{\cdot}6}$ = say 0·2842lb. Then 0·27273 × 0·2842 = 0·0775lb. as the weight of the quantity of steam in cylinder at point of cut-off. By Rankine's formula, the total quantity of heat contained in 1lb. of steam at 125lb. (calculated from results of experiments by Regnault) is found to be 1186·9, say 1187, heat units from water at 32°, as follows:—

	Units.
1. Required to raise temperature of water from 32° to 344·1° ..	315·1
2. To overcome internal resistance to vaporisation	790·2
3. To overcome external resistance to expansion	81·6
4. Latent heat of vaporisation (sum of 2 and 3)...............	871·8
5. Total heat of vaporisation above 32° (sum of 1 and 4) ..	1186·9
6. Normal temperature of steam at 125lb. (absolute pressure)	344·1°

The total heat, then, contained in the volume of steam is 1187 × 0·0775 = 91·9925 heat units, or but little more than twice the amount we have found the cylinder capable of absorbing for the 31·5° fall of temperature due to the final expansion. The quantity of heat actually lost by the steam from decrease of temperature due to expansion only may be ascertained by comparing the respective amounts contained at the two temperatures. These we find to be: for 262·5°, 1162 units; and for 231°, 1152 units, the difference representing 31·5° loss of temperature, being but 10 units per pound, or 10 × 0·0775lb. = 0·775 unit for the actual volume, or $\frac{0{\cdot}775}{91{\cdot}99} = 0{\cdot}0084 = \frac{84}{100}$ per cent. of the whole. This, it must be remembered, refers to the difference between the average of the 25 mean temperatures and that due to the mean steam pressure for the full stroke. The extreme difference between the latter and the initial temperature of the steam, 344°, will be 1187 − 1152 = 35 units × 0·0775 = 2·7125 units. This amount may be called the normal loss, as it is a theoretically inevitable condition or effect of expansion as represented by the hypothetical adiabatic expansion curve, and to it must be added the total loss from all other sources. Considering the effect on the cylinder from the temperature due to mean variation, we have $\frac{0{\cdot}775}{0{\cdot}123} \div 414{\cdot}25 = 0{\cdot}0152°$, and from the maximum variation $\frac{2{\cdot}7125}{0{\cdot}123} \div 414{\cdot}25 = 0{\cdot}05324°$, the former quantity, of course, being the effective one. Comparing this with the effect from a difference of 184·8° between the initial and terminal temperatures of the steam, as previously noted, we find that the quantity of heat will be 344° = 1187 (and 5lb. terminal pressure) = 162·4° = 1131 = 56 units difference. Then 56 × 0·0775 = 4·34, and $\frac{4{\cdot}34}{0{\cdot}133} \div 414{\cdot}25 = 0{\cdot}0854°$, the difference between which and the temperature due to mean variation being 0·0854° − 0·0152° = 0·0702°, or $\frac{0{\cdot}0702}{0{\cdot}0152} = 4{\cdot}67$, or 467 per cent. greater than the apparently true variation. On the theory, then, that saturated steam is at the point of both condensation and evaporation, the effect of the changes of temperature must cause a proportionate amount of condensation and re-evaporation, accompanied by a resultant increase of sensible heat in the former and decrease in the latter, the effect of which will be referred to later. In the foregoing, the loss of heat by the cylinder has been considered only with relation to its effect on the volume of steam during expansion. There is, however, another important result, which is the initial condensation, or that which occurs prior to cutting off. As the hottest part of the cylinder—*i.e.*, that included between lines 1 and 2—must at all times have a temperature considerably below that of the steam entering from the boiler, there must necessarily be a very considerable amount of condensation, which primarily decreases the volume and necessitates a further supply from the boiler to compensate for the loss; and secondarily, causes a very rapid increase in the amount of condensation (by reason of its high specific heat), from the fact that the water is in direct contact with the entering steam. The amount of initial condensation varies very widely in different engines; but for the purpose of comparison, we may assume a given percentage, say for the single cylinder engine, and note the effect on the actual steam consumption. For instance, it is not uncommon for this loss to amount to from 10 to 30 per cent., and if we call it 20 per cent. our volume of steam admitted up to point of cut-off becomes—not 480 cub. in., but 480 + 20 per cent., or 576 cub. in. Now, as to the effect of the secondary condensation, or that occurring during expansion. Owing to the give-and-take transfer of heat between steam and cylinder let us say that condensation is caused by one-half of the exposed surfaces, while the other half, at the higher temperature, is causing revaporisation of the film of condensed steam. Then, as the piston advances, the newly-uncovered portion of cylinder surface, being cooler than the steam, will condense a certain portion of the latter, the tendency being to continue the effect until the equilibrium of temperatures had been effected, or, in other words, until that of the cylinder should be increased to a point corresponding with the reduced pressure of the steam. Of course the rapid movement of the piston renders the interval of exposure too short to admit of such equilibrium being actually established, and the effect of the tendency in that direction must be proportionate to the duration of exposure. But while this condensation is going on we have the opposite effect from the previously-exposed and consequently hotter portions of the cylinder. Here the fall of pressure will allow of the revaperisation of the water of condensation in the effort to restore the equilibrium between temperature and pressure. This evaporation, of course, absorbs or renders latent a certain amount of sensible heat, but it does not follow that it is taken from the steam. On the contrary, owing to the high conductivity of the iron, and the actual contact between it and the water, the greater portion of heat absorbed will be from the cylinder, and therefore its effects will not be felt until the succeeding stroke. If this be a correct statement, then we should find the gain in pressure from revaporisation to be greater than the loss of condensation—that is, with relation to the effect on mean pressure for the full stroke,—for the reason that the amount of surface exposed to the higher temperature includes the areas of cylinder head and piston, while the cooler surface is only that of the internal periphery of the cylinder freshly exposed. That this is actually the fact appears to be demonstrated by the comparison of the expansion curve of the indicator card with that of the hypothetical diagram, as the former will show a pressure greater than that due to the mere effects of expansion. But while the greater mean effective pressure thus shown would apparently demonstrate a corresponding efficiency, it is not really the fact, as we must compare it, not with the indicated or nominal cut-off, but with the actual one, as represented by the additional supply of steam from the boiler necessary to make up for the heat previously abstracted from the cylinder, principally by the revaporisation of condensation water. Thus, if we construct a diagram upon the indicator card in which the point of cut-off is made to represent the actual volume of steam drawn from the boiler to fill our 480 cub. in. of space, we shall have (for the assumed initial condensation of 20 per cent.) 576 cub. in., or a cut-off of 1·728in., instead of 1·44in. The theoretical curve for this cut-off will be considerably higher than that shown by the indicator as representing the expansion due to the nominal cut-off and steam volume; and the difference between the two should represent the loss by cylinder condensation. To make the comparison, the new expansion ratio will be $\frac{12{\cdot}000}{576} = 20{\cdot}83$, the hyperbolic logarithm of which is 3·37; then $125 \times \frac{1 + 3{\cdot}37}{20{\cdot}83} = 26{\cdot}225$lb. as the mean pressure, while that due to the nominal cut-off is 21·095lb. And 26·225 − 21·095 = 5·13lb., which, divided by 21·095 = 0·243, or 24·3 per cent. less mean pressure than that actually due to the amount of steam drawn from the boiler. And this loss, it should be remembered, must occur irrespective of any external loss of heat by the cylinder, although it may be greatly increased when the latter is considerable from want of a proper jacket or non-conducting covering. Eliminating this portion of the subject, we may make the comparison between the single and double-cylinder engines entirely on the basis of cylinder condensation due to internal causes of variation in temperature. As in all calculations of this nature the quantity of heat, or heat effect, is directly proportionate to the area and number of degrees difference in temperature, it would seem that a comparison of the products of the areas by their respective variations of temperature should give the correct relative values of the two systems. For one single cylinder, then, we have in piston and cylinder head 666⅔ sq. in.; and in $\frac{1}{5}$th of stroke, 93 sq. in., making a total of 760 sq. in. of surface causing initial condensation. If we assume that the final revaporisation and low terminal pressure have reduced the surface of cylinder, say to the actual terminal temperature of the steam (although it will not be accurate as representing the actual loss), it will appear correct as the basis of comparison. Then 344° − 162·4° = 181·6°, and 181·6° × 760 sq. in. = 138,016. For the compound engine, we have in the small cylinder 100 + 100 sq. in. in piston and cylinder head, and 170 sq. in. for $\frac{1}{5}$th of cylinder area, making 370 sq. in. The difference of temperature is 344° − 240° = 104°, which × 370 = 38,480. In the large cylinder 500 + 500 + 379 = 1379 sq. in., which × (240° − 162·4°) = 77·60 = 107,010. The sum of these two quantities, 38,480 + 107,010, = 145,490, appears to indicate a loss greater than that of the single cylinder; but we must take into consideration the fact that while all of the revaporisation in the latter, occurring after relase, passes into the condenser without useful effect, that in the small cylinder, at the terminal of 25lb., becomes effective in the large one, and should therefore be deducted from the aggregate, making 107,010 as the loss by compound engine. The difference between this amount and the loss by single cylinder will be $\frac{31{,}006}{138{,}016} = 0{\cdot}225$, or 22½ per cent. saving by the former in the item of cylinder condensation—*i.e.*, if the net loss by the single cylinder be 20 per cent. of the initial volume, that by the compound engine will be but 77½ per cent. of 20 per cent., or 15½ per cent. net loss, as representing the initial condensation. Then, as by previous calculation of percentage of loss in mean pressure due to the actual volume of steam drawn from boiler, we have $\frac{100 \times 24}{480 + (480 \times 0{\cdot}155)} = 4{\cdot}275$ as the new expansion ratio—the hyperbolic logarithm being 1·4663. Then $125 \times \frac{1 + 1{\cdot}4663}{4{\cdot}275} = 72{\cdot}14$, and as we have found in the value of C for five expansions (Part I.) a mean pressure of 65·24lb., the difference—6·9lb. = 0·1057, or 10·57 per cent.—represents the deficiency in mean pressure as compared with that due to the actual steam consumption. The saving, then, by compounding appears from our calculation to be as $\frac{20 - 15\frac{1}{2}}{20} = 22\frac{1}{2}$ per cent., and entirely on the basis of cylinder condensation, as assumed at 20 per cent. of the nominal volume of steam in single cylinder engine. As to the effect of external sources of heat loss, it seems hardly necessary to go into detailed calculations, as with equally efficient non-conducting coverings (which are applicable to both types of engines) the only difference in effect will be directly proportionate to the difference of external areas. In the foregoing, of course, the object has been not to show the actual amount of saving by the compound system, but rather to point out some of the erroneous methods of calculation, and to suggest a course of investigation apparently in the right direction. From the absence of any accepted explanation of the phenomena involved in compound expansion, it is reasonable to consider the question as one still to be solved, and it is hardly probable that this can be convincingly done without the most exhaustive experimental investigation on the scale of full practical operations. The expense necessarily involved in such tests places the subject beyond the reach of individual effort, which may probably account for our lack of absolute information, beyond the mere comparison of fuel consumption, as shown by the indicated power of engines of the two types.

Trade Notes.

Messrs. A. and J. Stewart and Clydesdale Limited, Glasgow, have secured a large order for oil pipe-line tubes.

The contract for the construction of an iron girder bridge at Dyer's Hill, Sheffield, has been awarded to Messrs. Townsend and Waton, Sheffield.

Messrs. Alexander Dobbie and Son have acquired the business of the late Mr. T. S. M'Innes, steam indicator maker, York-street, Glasgow.

The Malleable Iron and Steel Company, Portrack, Stockton, have secured an order for 3000 tons of steel plates, which are for H.M.S. "Renown," now being built at Chatham.

Messrs. J. Sagar and Co., of Halifax, have received an order from Messrs. Illingworth, Ingham and Co., of Leeds, for a large band-sawing machine.

Another important order for plant and machinery for a foreign sugar refinery has just been placed with Messrs. J. and R. Houston, engineers, Greenock.

Messrs. T. Balmforth and Co., Luton, are erecting a number of new hearths, in order to cope with the extensive demand for boilers for the export trade.

Messrs. Davy Brothers Limited, engineers, Sheffield, have recently completed a pair of rolling mill engines for Messrs. Brown Bayley's Steel Works Limited.

The Staveley Iron Company have secured the contract for the supply of 36in. cast-iron pipes and other materials required for the Boscombe Outfall, Bournemouth.

Messrs. R. M'Laren and Co., ironfounders, Possil Park, have secured the order for the cast-iron pipes for the Glengavel water supply in the Middle Ward of Lanarkshire.

Messrs. Krupp, of Essen, have received an order from 1000 tons of steel rails and other material, from the German East African Company, for the construction of the Usambara Railway.

Messrs. Reynolds Brothers and Wright, Albion Foundry, Willenhall, are carrying out important extensions at their works. The alterations include the erection of two additional cupolas.

Messrs. R. Shram and Co., mining engineers, London, supplied the air-compressing and rock-boring machinery which was successfully used in connection with the raising of H.M.S. "Howe."

The order of the Govan District Lunacy Board for engines, boilers, etc., at the farm steading at Hawkhead has been placed with Messrs Hall-Brown, Buttery and Co., Helen-street Engine Works, Govan.

The directors of Messrs. Alldays and Onion's Pneumatic Engineering Company, Birmingham, have declared an interim dividend for the half-year ended December last at the rate of 10 per cent. per annum.

Messrs. A. Walker and Son, Thornhill, Dewsbury, have contracted to supply a pair of Messrs. Tangyes' type of 14H.P. horizontal engines, two large steel boilers, centrifugal pumps, etc., to the local authorities at Thornhill.

The directors of Messrs. Robert Boyle and Son Limited, ventilating engineers, London and Glasgow, have resolved to pay an instalment on account of dividend at the rate of 12 per cent. per annum for the half-year ending March 31 last.

Messrs. Sir W. G. Armstrong, Mitchell and Co., Newcastle-on-Tyne, have nearly completed the new hydraulic coal hoists for the Alexandra Docks, Newport, Monmouthshire. When in operation these hoists will greatly facilitate the shipment of fuel at the docks.

Mr. Richard White, iron merchant, Widnes, Lancashire, has obtained the order for the whole of the permanent-way chairs required by Messrs. T. Pearson and Son, Westminster, for their section of the Lancashire, Yorkshire and East Coast Railway.

Messrs. Siemens Brothers and Co., electrical engineers, London, have received an order for the supply of dynamos, regulators, arc lamps, underground conductors, etc., required in connection with the scheme for lighting the city of Londonderry by electricity.

Messrs. Gourlay Brothers and Co., shipbuilders, Dundee, have contracted to build a steel screw steamer of about 900 tons gross register to the order of an Austrian firm. The engines are to be of the triple-expansion type, and will drive the steamer at a speed of about 13½ knots per hour.

Having regard to the enormous circulation of THE MECHANICAL WORLD, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if MECHANICAL WORLD readers will kindly bear this in mind as occasion arises.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 65, Strand London, or New Bridge-street, Manchester.

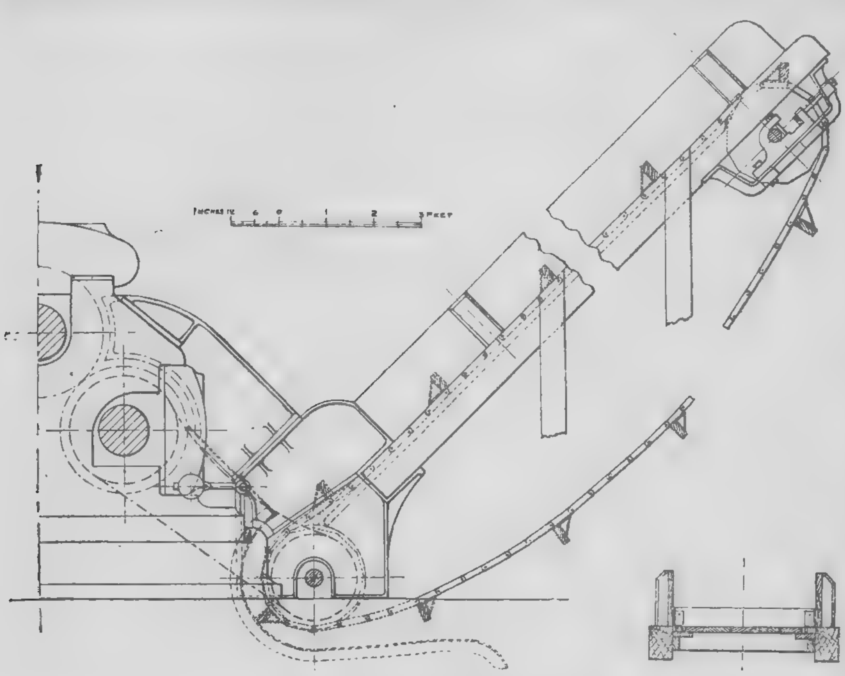
Sugar-making Machinery.

XXX.

Megass Elevator.—The construction of the megass elevator is very similar to that of the cane carrier. The megass boards and table are generally set at an angle of 45°, so that the megass or crushed cane will fall away readily from the rolls. The form of megass boards are generally made according to taste and to suit adjusting provision thrown forward and so leave back roller free or exposed for cleaning purposes.

Fig. 75 shows a section of a megass scraper board 2in. thick by 5½in. deep and 7in. pitch chain, and method of attaching scraper to chain by small angle brackets.

The driving clutch (Fig. 76) is usually fitted to end of lower elevator drum shaft (or sometimes to megass roller gudgeon), and is provided with teeth cast on for a 5in. pitch chain, which receives its motion from a corresponding chain wheel on roller shaft. This wheel is, as shown, provided with a ratchet and pair of pawls, so that in the event of the mill having to run backwards at any time, the megass which has already passed the mill will not run back to the rollers again.

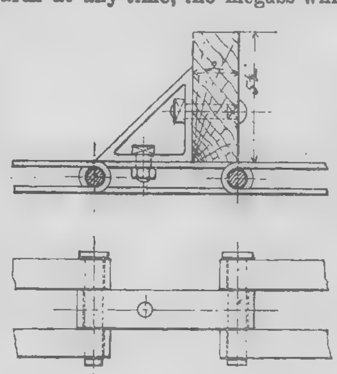


SUGAR-MAKING MACHINERY.—FIG. 73. FIG. 74.

on the mill cheeks; the thickness of metal in boards being about ½in. for small mills, and ⅝in. to ⅞in. for mills of a larger size, ⅝in. being a good average thickness. Side-stiffening ribs, from 3in. to 5in. deep.

Fig. 73 shows an elevation of elevator for a 32in. mill. The bottom drum of the elevator is placed in a convenient position below the megass boards and table, the drum being surrounded by a circular trough or invert, made of plate iron, about $\frac{5}{16}$in. thick (with angle-iron stiffening pieces at sides), with an annular space of about 4½in. to 6in. wide between, to receive the megass. This annular space is swept over by the timber megass scraper secured to the 7in. pitch chain carried by the cant wheels on each end of elevator drum, and lying in groove shown in section of elevator (Fig. 74), the megass being pushed in front and onwards to the point of discharge at top.

The elevator is generally arranged to elevate the megass to a considerable height, so as to deliver into a hopper from which it can be discharged into trucks for conveyance, on a raised platform, to the furnaces, or megass logies, or drying-houses.



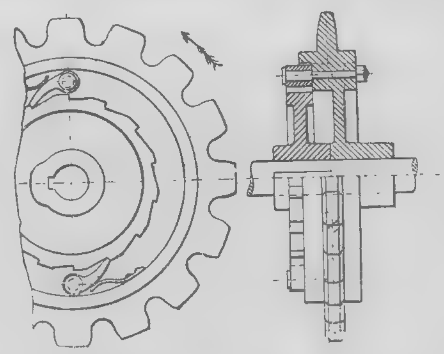
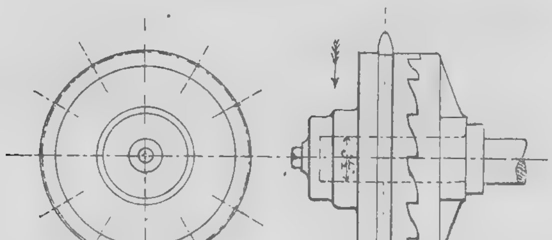


FIG. 75. SUGAR-MAKING MACHINERY. FIG. 76.

Fig. 77 shows another form of driving clutch, with saw-teeth cast on for the same purpose as already mentioned with regard to Fig. 76. On the circumferences of this clutch are fitted forged iron or steel teeth bolted on with nuts inside. The cant wheels on elevator drums have usually 8, 10 or 12 cants, and front or lower pair are provided with teeth corresponding to the number of cants.



SUGAR-MAKING MACHINERY.—FIG. 77.

Sometimes the elevator is required to be taken at right angles to the cane carrier, in which case the motion has to be taken by means of bevel wheels to the bottom drum.

The top shaft of elevator (about 3½in. to 4in. diameter) is carried on stretcher blocks in brackets fixed on underside of side stringers. On each end of shaft inside the stringers is placed the cant wheels (without teeth) carrying the 7in. pitch chain. The means of taking up the "stretch" in the links is clearly shown. Timbers stringers about 7in. square; side boards, 14in. by 1½in.; width of elevator for this size of mill, about 3ft. between side boards.

The speed of megass elevator is from 15 to 25 per cent. faster than the surface speed of rollers. Megass table is pivoted to boards at each side, and kept up to roller by means of lever and balance weight, which, as occasion requires, can be

(*To be continued.*)

A GOOD PLAN of preventing tools from rusting is the simple preparation employed by Prof. Olmstead, of Yale College, for the preservation of scientific apparatus. It is made by the slow melting together of six or eight parts of lard to one of resin, stirring till cool. This remains semi-fluid, ready for use, the resin preventing rancidity and supplying an airtight film. Rubbed on a bright surface ever so thinly it protects and preserves the polish effectually, and it can be wiped off nearly clean, if ever desired, as from a knife blade: or it may be thinned with coal oil or benzene.

Screw Cutting.

A WRITER in our esteemed contemporary, the "American Machinist," in the course of some remarks on screw cutting, says:—Most lathe builders make the teeth of the change gears increase in number by arithmetical progression, and I think it is a good way, as it makes it easy to figure threads that do not happen to be on the index plate. The numbers most used as a common difference are 5, 6, and 7. Now take any lathe whose change gears increase in number of teeth by a common difference, and it is only necessary to multiply the number of threads in the lead screw in a certain distance, and the number of threads in the screw you wish to cut in the *same* distance, each by the common difference of the teeth of the change gears, and it will give the correct gears for that thread. For instance, we wish to cut 11 threads per inch, and the lead-screw has four threads per inch, and the common difference of the gears is seven teeth. In 1in. of the lead screw there are four threads, and in 1in. of the desired thread there are 11 threads; therefore, $4 \times 7 = 28$, and $11 \times 7 = 77$, giving 28 and 77, which will cut 11 threads per inch.

Now suppose we wish to cut 4½ threads per inch; as 4½ will not multiply by 7 without a fraction, we will take 2in. of each thread; 2in. of lead screw = 8 threads, and 2in. of desired thread = 9 threads; then proceed as before: $8 \times 7 = 56$, and $9 \times 7 = 63$, giving 56 and 63 as the correct gears for 4½ threads per inch.

Now suppose we have a 3¼in. bolt on which to cut 3¼ threads per inch. In order to figure 3¼ threads per inch with the number seven as a basis for the change gears, it will be necessary to take 4in. of each thread, as 3¼ per inch and 4 per inch will not come together without a fraction in less than 4in. Therefore, in 4in. of lead screw there are 16 threads, and in 4in. of 3¼ threads per inch there are 13 threads, and $16 \times 7 = 112$, and $13 \times 7 = 91$, giving 112 and 91 to cut 3¼ threads per inch, and as the product of the lead screw and the common difference gives the driver, the 112 gear will be the driver in this case.

The method will work just as well when the lead of the thread in inches, or parts of an inch, is given. For instance, we wish to cut a worm of $\frac{9}{16}$in. pitch; now $\frac{9}{16}$ of an inch to one turn of worm, and ¼ of an inch to one turn of lead screw, will come together in 2¼in. In 2¼in. there are four threads of $\frac{9}{16}$in. lead and 9 threads of ¼in. lead; therefore, $9 \times 7 = 63$, and $4 \times 7 = 28$, the correct gears to cut $\frac{9}{16}$in. pitch, 63 being the driver.

This rule will in all cases give the smallest pair of gears that will cut the thread when the common difference of the gears is a prime number. In case it gives a pair of gears that are too small for convenience, double or triple the size of both gears.

Outside Lighting of Shop Windows by Electric Light.

THE efficient external illumination of shop windows by means of the electric light has long engaged the attention of practical electricians, and many attempts, more or less crude and unsuccessful, have been made to solve the problem. For this class of lighting a simple junction is required to make the electrical contact, permitting the use of an outside reflecting lantern somewhat after the type of the reflecting gas lamp. The points of most importance that should be possessed by any junction designed for this purpose are:—

Complete protection of the electrical contacts from the weather and high insulation, so that the whole installation may pass the insulation tests demanded by the insurance companies. Good rubbing contacts of ample size to carry the current without any fear of heating. Simplicity in construction, and making it impossible for it to get out of order or becoming short-circuited, shop assistants not being, as a rule, very careful manipulators of mechanical appliances.

It is very doubtful if the ordinary gas-lamp joint can be adapted to meet any of the foregoing requirements; it can certainly not be pretended that, as sometimes adopted, it meets them all.

We give herewith an illustration of Wynne's patent detachable lamp junction (Fig. 1), which has been specially designed, after much experience in this class of work, for the external lighting of shops and other

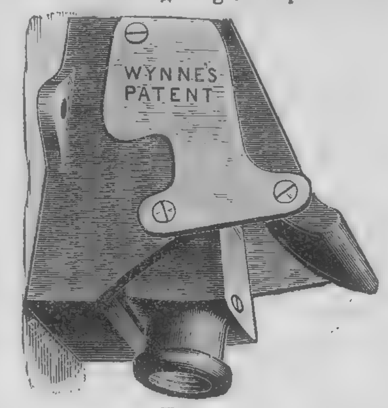


FIG. 1.

purposes. By means of this joint a reflecting lantern, very similar in design to those used for outside reflecting gas lamps (Fig. 2), can be put up or taken down with great ease and rapidity by the most inexperienced person. The joint consists of a strong outside metal hood to be permanently fixed to the facial board above the shop window, or in other convenient position, and a movable contact piece screwed

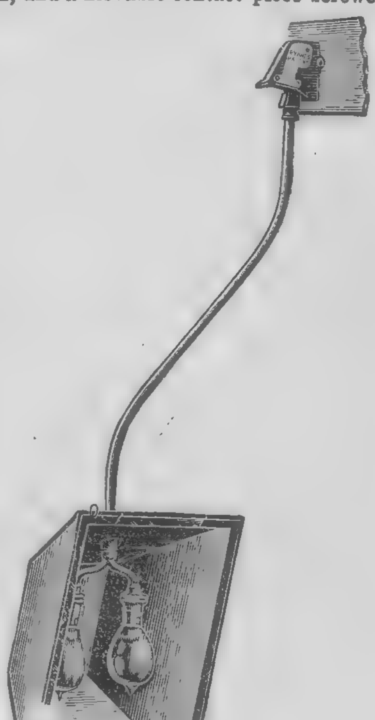


FIG. 2.

on to one end of a short length of iron pipe, the other end of which is fastened to the reflecting lantern. The contact piece is inserted at a slight angle into the open mouth of the hood from underneath, and when allowed to fall into its place becomes thoroughly rigid and the electrical contact made is perfect. There is no complication about the joint, the hood is perfectly watertight, and the connections highly insulated, and of ample size and strength. Messrs. Wynne and Barnard, electrical engineers, 72, Grey-street, Newcastle-on-Tyne, are the patentees and manufacturers of the joint.

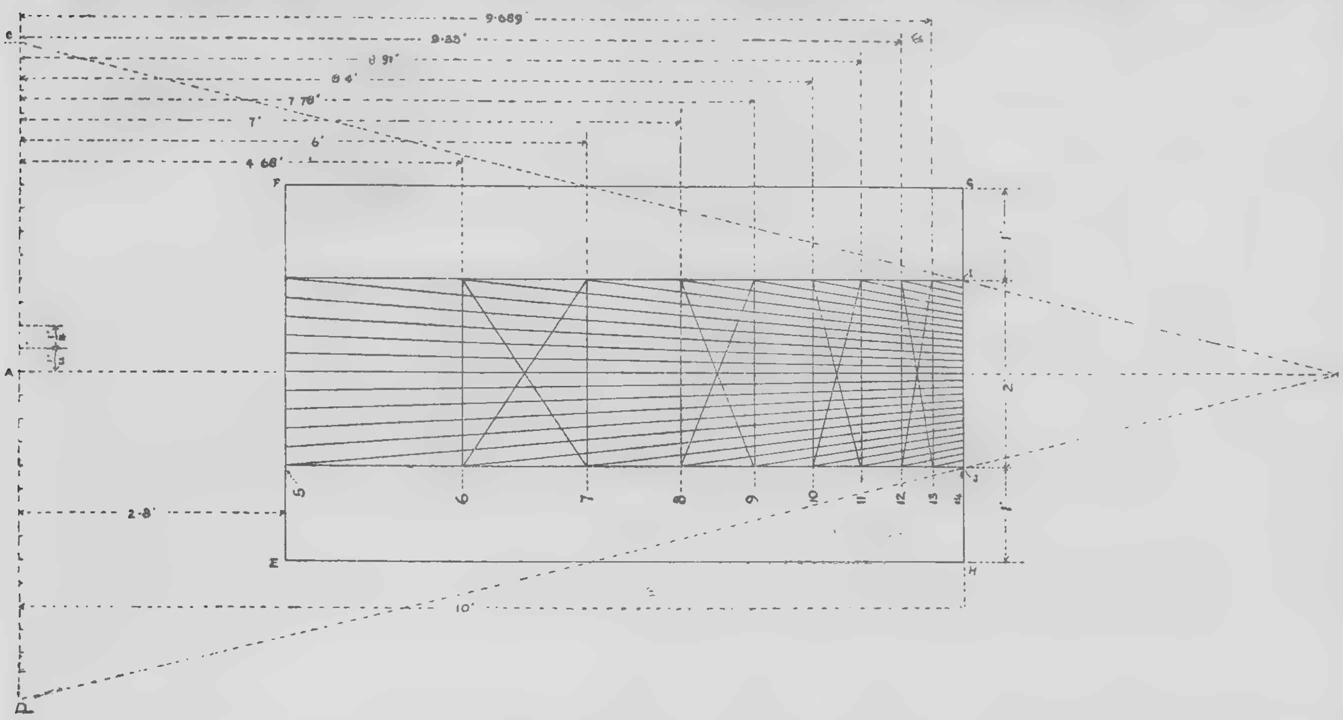
THE last discussion meeting for the session of the Manchester Association of Engineers was held on the 8th inst. at the Grand Hotel, Aytoun-street, Mr. T. Daniels, the president, in the chair. Mr. A. Saxon read a paper on the best design of main and other bearings. In the course of his address, which was of a technical character, Mr. Saxon said there was no special design of main bearing that would meet all the circumstances and conditions with which engineers were called upon to deal. There was, in fact, no universal bearing that fulfilled all requirements, but out of a number of different designs it was their business to select and recommend the best and most suitable which knowledge and experience could suggest for the particular case before them. A discussion followed the reading of the paper.

Nut and Thread Gauges for Draughtsmen.

[CONTRIBUTED.]

THE accompanying illustrations show a gauge for drawing hexagon nuts, and another for making from five to fourteen threads per inch. Both gauges must be accurately drawn (full size) upon Bristol board or hard thick paper. In use they are applied direct to the drawing, dividers not being required.

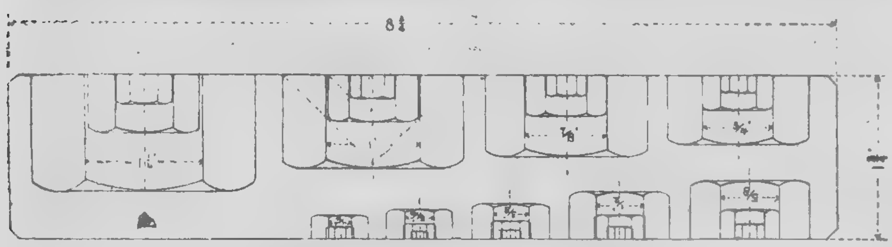
Only one side of the nut gauge is shown, marked for dimensions across the angles of hexagon nuts. The other side is arranged in the same way, but with dimensions across the flats. Full, half, and quarter size are drawn one within the other, thus greatly economising space.



NUT AND THREAD GAUGES FOR DRAUGHTSMEN.

The central division of each nut is not exactly the width of a flat, but equals the diameter of bolt, according to general drawing-office practice.

In making the gauge a scale divided into 10ths, or preferably 50ths of an inch, will be required, and the full-size dimension across the corners in inches and decimals of an inch must be accurately taken with dividers, and marked on the card. This dimension, with the heights and central flats, are the only ones scaled. The centre line, half, and quarter-size widths are obtained by geometrical construction. From the points marking the extreme width, draw two lines at an angle of 45° with the base, and through their point of intersection draw the centre line perpendicular to the base. Then from the centre of base project another line at the same



NUT AND THREAD GAUGES FOR DRAUGHTSMEN.

angle, and where it cuts the diagonal draw a line perpendicular to the base. This will be the outside corner of the half-size nut. The method is illustrated in the case of the 1in. size. Experience has proved this to be the most accurate method. When completed, the nuts should be tinted blue, which greatly improves the appearance. The dimensions of Whitworth nuts are as follow :—

	¼in.	$\frac{5}{16}$in.	⅜in.	½in.	⅝in.
Across angles..	0·606	0·694	0·819	1·061	1·271
Across flats	0·525	0·601	0·709	0·919	1·101

	¾in.	⅞in.	1in.	1¼in.
Across angles..	1·502	1·707	1·928	2·36
Across flats	1·301	1·479	1·67	2·018

The design of this nut gauge being the author's copyright, it can only be made for sale by special arrangement. Any reader, however, is at liberty to make one for his own use, and the trouble will not be regretted.

In the case of the thread gauge, the diagram being fully dimensioned little explanation is necessary. The apparent complication is caused by the dotted lines, which are only to assist the draughtsman, and do not appear on the finished article. The gauge itself is bounded by the full line E F G H. First draw AB 14in. long. Then AC, AD, each 3½in., and divided into fourteen equal parts. The illustration explains the rest. The crossed rectangles are *cut out of the paper.*

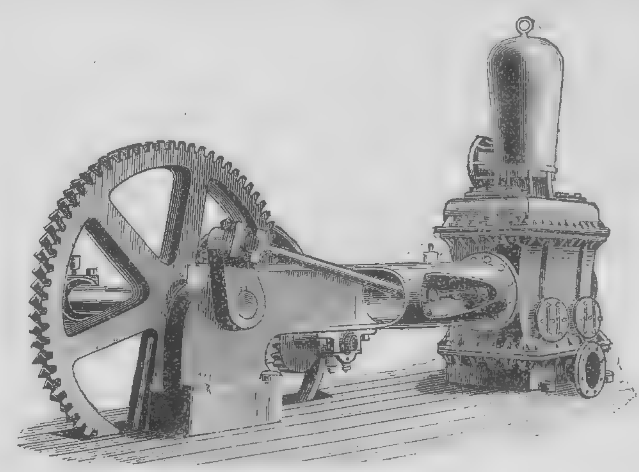
Incandescent Gas Lighting.

THE extended use of electricity as a lighting agent has brought into prominence many systems of gas lighting, but probably few have proved so keen a competitor of the electric light as the Welsbach system of incandescent gas lighting. This principle of lighting has now been in use for some time, but recently several improvements have been introduced which have materially increased the efficiency of the system. It may be explained that the Welsbach system differs from ordinary methods of burning gas, inasmuch as the light is not produced by the actual gas flame, but by a heating and non-luminous flame which impinges upon a gauze mantle, rendering the latter brilliantly incandescent. Considerable progress has recently been made in the manufacture of these mantles, and at the present time many costly metallic oxides are employed in their manufacture. The mantle is made originally of cotton thread, woven into a cylindrical form. It is then impregnated with solutions of the metallic salts, after which the cotton is burnt out, leaving a skeleton, so to speak, of the oxides, having the exact form of the original substance. The life of the mantle is given at about 1500 hours, but they can be quickly and readily renewed. Recently a new form of burner, "C" pattern, has been introduced, which, while consuming about 4 cub. ft. of gas per hour, gives a light of from 70 to 80C.P. If this is compared with an ordinary Argand burner consuming 8 cub. ft. of gas per hour, and giving a light of 20 candles, the superiority of the incandescent system is at once rendered apparent. The makers further claim that, as the combustion is perfectly effected, the atmosphere remains pure, while the heat given off is considerably less than when gas is consumed in the ordinary way. Further, the light is perfectly steady, and does not affect colours, which appear as in daylight. The Incandescent Gas Light Company Limited, 14, Palmer-street, Westminster, and 55, Market-street, Manchester, are the makers, and will supply further particulars on application.

THE Chicago Exhibition authorities have determined to dispense with the use of coal for the boilers at their forthcoming World's Fair, and to employ petroleum exclusively.

Heavy-pattern Geared Pump.

WE have in previous issues described and illustrated various installations of pumping plant which have been designed and erected by the Pulsometer Engineering Company Limited, Nine Elms Ironworks, London. This firm, as is well known, have long made a speciality of pumping and filtering appliances of various kinds. In the accompanying illustration we show a recent form of heavy-pattern geared pump of the Deane type, made by this firm for a large mill in Russia. The pump is 16in. in diameter, and has a stroke of 24in. As will be seen, helical spur gearing is employed. The second-motion shaft is fitted with striking gear and fast and loose pulleys. The pump is designed for raising 52,000 gallons of water per hour to a height of 100ft. It is of very substantial construction, and will no doubt prove of ample power for the service named. We may add that the Deane pump is made in



HEAVY-PATTERN GEARED PUMP.

a large variety of forms—as a fire pump, hydraulic-pressure pump, double-plunger sinking pump, deep-well pump, etc.

Haines' Automatic Micrometer Gauge.*

THE automatic micrometer gauge described was designed to meet the demand for more accuracy in rolling sheet, bar or plate metal to exact thickness than has heretofore been obtained by the ordinary fixed or caliper gauges. It was specially designed for gauging hot work while in the act of rolling, so that the roller might know, at each pass of the metal through the rolls, the exact amount of reduction and what adjustment were necessary for the succeeding pass, and finally to finish the work to the proper thickness. In rolling such material as boiler, ship, or tank-plate, this is particularly important. The rolls cannot be set as in a rail mill, where large quantities of duplicate pieces are turned out, but must be adjusted constantly for each plate rolled. One plate is to be finished ⅜in. thick, the next ¼in. thick, the following 1·13in., the next ½in., and so on. This applies as well where a large number of plates of the same thickness are required, as the rolls must be opened wide enough to receive the bloom or ingot, then are gradually closed together while the bloom is passed backward and forward between them till the desired thickness is reached. In modern mills there is an indicating attachment connected with the large housing screws (for closing the rolls together) that will show how much the bloom is being reduced by each pass, and will give an approximate idea when the plate is reduced to the proper point; but it can never be relied on to determine the exact amount required for the finishing pass, as it will not measure the compression of the screws and bearings, the springing of the rolls, or make allowance for the extra diameter caused by heating. Hand gauges must, therefore, be used to make this determination. The instrument in common use is the fixed or caliper gauge, and just herein lies the difficulty in getting accurate work. Take, for instance, the plates for a marine boiler. These are usually of a large size, a single one often weighing 6000, 8000, or 10,000lb., and gauging (say) ⅞, $1\frac{1}{32}$, or 1½in. They are calculated by the engine designers to a certain thickness, in order to carry a suitable pressure for the engines. Should they fall below this thickness, the safe working pressure is cut down for every $\frac{1}{100}$in. under the gauge; if the plates should be over the calculated thickness, the purchasers object to the excess of weight. In either case allowances must be made, or the material is rejected, both of which are undesirable. In making these plates, suppose a common fixed caliper gauge is used. The roller, judging by experience when the plate is nearly down to thickness, tries the gauge on it. One of three things happens—either the gauge will not go on the plate, or it will go on just right, or else will go on too loosely. If it goes on too loosely the mischief is done. If it fits just right the point is gained, but when the gauge will not go on the plate there is yet a chance to make it right or spoil it. To make it right another pass is necessary, and a definite knowledge of the amount of reduction required is of vital importance. With the fixed gauge this is mere conjecture. It may take two or three passes of very slight reduction each; but that takes time, and there is still a risk of going too far, whereas, if the exact amount were known, one pass would have sufficed. The need to determine definitely this unknown quantity led to the invention of the automatic micrometer gauge. Heretofore it was hardly necessary to work to such close measurements; but the tendency of the present time along all lines is toward greater accuracy, and what would have passed a short time ago is rejected to-day. The automatic micrometer gauge is somewhat similar in general character to a micrometer caliper, but the construction is different, as the conditions of use are not at all similar. The gauging screw is made with coarse pitch and double thread, and has for a head a graduated disc about 2½in. in diameter, which indicates the measurements. The edge of this disc is serrated, and can be clamped or held at any point, to prevent turning, by a locking bar or knife edge arranged to slide in between the teeth at the will of the operator. The movement of this locking bar is controlled by a trigger (on the gauge handle), operated by the forefinger. The handle is made of sufficient length to enable the person using it to measure hot work with ease. Fastened to the gauging screw, directly under the disc, is a spiral spring, which tends to rotate the disc, and thus close the screw upon any article to be measured. In practical working—for instance, in gauging a hot plate—the dial is turned by hand (to open the gauge screw)

* Paper by R. B. Haines, read before the Franklin Institute.

to considerably more than the finished thickness of the plate; the gauge is then put on the plate, and the trigger pulled. The spiral spring causes the disc to revolve, and sets the gauge screw on the surface of the plate. The trigger is now released, and the locking bar engaging the teeth of the disc prevents it from turning while the gauge is pulled off the plate to take the reading. The graduations on the face of the disc indicate the thickness. This can be repeated at each pass through the rolls, and will show the amount of each reduction. In following the work down in this manner, the exact amount of reduction for the finishing pass will be determined. The whole operation is extremely simple, yet gives the gauger at all times definite measurements that show at each step just what is being done. The gauge weighs about 2¼lb. It is operated altogether with one hand, excepting when set for the first time for each plate.

A single one replaces all the fixed caliper gauges for standard thickness (within its range), and obviates entirely the expense of making special gauges for special thicknesses. In our own work we seldom roll plates less than 3/16in. thick, and between that and 1½in., which is about the heaviest. We formerly used 33 caliper gauges, besides frequently making special tools for odd sizes.

These we have now discarded, and use in place of them three of the automatic micrometer gauges.

We have had them in use for several months, and the result shown in the increased accuracy of the work is very satisfactory.

Some Thoughts on Boiler Inspection.*

THE simple words "boiler inspection" may be considered as meaning but very little, or they can be regarded as encompassing a great deal. In its simplest form, the duty of a boiler inspector may be performed by the ordinary boilermaker, who, by a hasty glance, only observes the conditions of exposed surfaces and passes rapidly all parts not showing considerable irregularity of surface or having the appearance of leaks. On the other hand, it may be said that the proper fulfilment of boiler inspection is far-reaching; that such duties should commence with the manufacture of the plate; that it should include the tests which boiler plate is necessarily subjected to; that such inspection should guide and assist in reaching designs intended to meet certain demands and requirements under well-established conditions. Inspection should establish and conduct the tests which a complete boiler is required to undergo; it should outline the character of the test power, decide how long such test should be maintained, and what to be observed during the operation. Inspection duties lead on to the boiler in service, where it must institute the most critical examination as to how the several parts are performing required duty; must direct special attention to the extent of deterioration in part or as a whole; and finally pass on the methods pursued by persons charged with its care and management. Briefly stated, then, boiler inspection should commence with the manufacture of the boiler plate, pass successively on its strength and endurance, on the design and construction, on the manner of conducting and treatment in testing, observe its performance in service, establish periodical testing, and institute the most intelligent methods for its care and management.

Passing to the design and construction of a boiler, both of which should be under the eye and subject to the advice of the experienced inspector, at this point it may be proper to call attention to the fact that of all structures we are called on to design, those of boiler dimensions in detail are the most important.

The boiler, with its relative parts, is the most important part of the locomotive. On its power to meet necessary requirements depends to a great extent the economy and efficiency of our lines of transportation. There are some grounds for the belief that if the design and dimensions of locomotive boilers were given thought to as great a degree as that directed to improving the compound principle in locomotive engines, the result would be much more satisfactory in the direction of both economy and efficiency.

In all parts of boiler erection the inspector should play a ruling part, and should be granted the greatest freedom in reaching conclusions as to the character of the work performed. There is scarcely a doubt that the strength and quality of boiler plate are often overtaxed and unduly strained while in the hands of a boilermaker. The plates have to undergo the various processes of heating and cooling, hammering hot and cold, bending, twisting, flanging, and punching, to say nothing of the evil of the draft pin or of hidden defects which are likely to occur in the plate.

There is certainly a possibility of bad and careless riveting, plates overheated in flanging, or cracked, if only slightly, in bending, and many other defects, which may be traced to want of skill or reckless negligence on the part of the workmen.

It is clearly evident that the material for a boiler may be of the most superior quality sanctioned by use, and yet, if not skilfully handled and most carefully attended to during the process of preparation to take its place in the completed boiler, it may be reduced to a point less in strength and endurance than material of the most inferior grade. . . .

Opinions differ as to the best means of applying pressure in order to ascertain the strength of a boiler. Some advocate the hydraulic, others the steam test. In favour of testing by steam, it is urged that it is the only means by which the conditions of strain can possibly be the same as those under which the boiler is worked. No doubt this is in the main true, but as a matter of safety a steam test should only be applied after the strength of the boiler has been ascertained by the water test.

In making a full test of a boiler, new or old, before a pressure is applied, the various parts, particularly those suspected of weakness, should be measured and gauged and the results carefully noted. After the test pressure (which should not be more than 40 per cent. in excess of the working pressure) is maintained for some time, the measurements previously obtained should be checked, and any extension, changes of form, distortion, bulging, etc., carefully noted. Then, again, after the pressure is released any changes in measurements that may have been found should be known, whether permanent or not; and it seems to the writer that right here is a highly important point, one that should receive the most serious thought, in that, if there be any permanent enlargement or distortion, even in the slightest degree, it should be thoroughly examined to decide whether it is due to the elastic limit of the material having been exceeded or to improper construction. In all cases where permanent set is discovered the test should be repeated again and again if necessary, in order to ascertain if the set becomes increased.

In whichever manner a boiler is tested, too great care cannot be exercised in obtaining the exact amount of pressure applied. Gauges in general are too apt to get out of order to be implicitly trusted when only a single gauge is used. It is therefore urged and recommended that in all cases of important boiler testing not less than two gauges be used, in order to establish to a certainty the exact pressure applied.

It may be remarked here that the test pressure should be maintained for some considerable time, say half-an-hour or more. The continued pressure has often been known to lead to the detection of weakness, when, if such pressure had not been maintained, the defect would have escaped unobserved. . . .

From this it would appear that all boilers, when new or newly repaired, should be tested first by hydraulic pressure, and after by steam, the latter to determine what, if any, unequal expansion exists, to what extent, and what results have been produced.

The wear and tear of a boiler in service is an important feature for the inspector to keep in mind. From the hour the boiler is set at work it is acted upon by destroying forces, and many of them are almost uncontrollable in their work of deterioration. Internal corrosion is the malady that most boilers suffer from. Corrosion presents itself in various forms. Sometimes it happens that it is mainly the transverse seams, rivet heads and plate edges that are attacked; in other cases it is the longitudinal seams alone.

The stays are often more violently attacked and more rapidly wasted than the plates. A threaded stay will be attacked at the thread, while the unbroken or unturned surfaces will escape.

The body of a plate away from any disturbing influence is often attacked by furrowing and pitting, and in consequence of this apparent weakness has often been condemned and removed. The writer has seen plates removed from this cause when, although corrosion had taken place to some extent, there was left much more metal and consequent strength than were possessed by the next section of the plate through the rivet holes. This is an expensive mistake, and inspectors ought to guard against it.

Much is lost by improper care and unintelligent management of boilers in service. It seems unnecessary to remark that the management and care of boilers should be treated with as great a degree of intelligence as their design and construction. Excellent points to avoid are sudden and unequal expansion and contraction as a whole or in part. Blowing out a boiler while hot, and washing it out with cold, or comparatively cold water immediately thereafter, is one of the most destructive and expensive practices of the service. Rapid and forced firing in a boiler which has been out of service and permitted to cool is also a boiler evil of the highest order. Permitting the entrance of cold air through the door or dampers immediately following the dumping of the fire is on a par with the worst evils, and its result is always apparent by the development of leaks.

To the correction of such disturbing elements as the above, together with numerous abuses in the care of boilers, it is desired to direct the attention of inspectors, but the extent of correction will depend largely on the intelligence and common sense of the persons charged with inspectors' duties. It is readily seen that on the proper fulfilment of boiler inspection depends much public comfort, public expenditure, and safety to public life and property. To perform the duties of boiler inspectors conscientiously and well, the position can be no sinecure, and it can only be successful with the aid of experience in boiler design, construction, and requirements, together with a full understanding of the direction in which the forces are applied while in service, as well as under the stresses of test. . . .

It is apparent that the office of supervisors of boilers is an indispensable adjunct to the mechanical department of railways. The design, construction, and management of boilers are deserving of the most thorough and scientific study, and it is only by organising especially for the purpose that the subject is certain to receive due attention and necessary thought.

It is thought best to suggest, further, that it is the bounden duty of all persons charged with the care and maintenance of steam boilers to highly encourage any steps towards the manufacture of an improved grade of boiler material, and to support all efforts towards a higher order of intelligence in the arts of boiler design, boiler construction, and boiler management.

* Paper by John Hickey, Northern Pacific Railroad, read before the North-West Railroad Club.

The Mineral Production of the United Kingdom.

THE "Summaries of the Statistical Portion of the Reports of Her Majesty's Inspectors of Mines for the year 1892," which have just been issued, show that a general decline took place last year in the output of minerals. The total quantity was 191,954,908 tons (against 197,693,592 tons in 1891), of which 181,786,871 tons (against 185,479,126 tons) were coal, and 5,644,486 tons (against 7,229,150 tons) were ironstone, the rest being fireclay, oil shale, and other minerals. There was thus a total decrease of 5,738,684 tons, or 2·89 per cent., compared with 1891, the decrease in coal being 2,692,255 tons, or nearly 2 per cent., and in ironstone 1,584,644 tons, or almost 22 per cent. The total number of persons employed in and about the mines, inclusive of those employed on private branch railways and tramways, and in washing and coking coal on premises adjacent to or belonging to the mines, amounted to 721,803 (against 707,411 in 1891), which shows an increase of 14,397, or 2 per cent. Exclusive of those engaged in the two latter industries the number of persons employed was 702,466, which, compared with 1891, when 687,878 persons were employed, is an increase of 14,588, or 2·1 per cent. The total number of fatal accidents was 862, and the total number of deaths caused thereby 1034; being a decrease of 99 in the number of fatal accidents, and an increase of four in the number of lives lost, compared with the totals of the preceding year. There was one death for every 679 persons employed, which is rather more favourable than the ratio of one in 668 in 1891. Comparing the number of fatal accidents and deaths with the tonnage of minerals raised, it is found that last year there was one fatal accident to every 235,817 tons of minerals produced, and one death to every 195,473 tons. This compares favourably with 1891 as regards fatal accidents, there being in that year one fatal accident to every 217,007 tons; but is less so with regard to deaths, there being but one death in 1891 to every 201,934 tons.

Metal Trade Memoranda.

The Moslyn lead mine, near Youlgrave, has been reopened after having been closed for a considerable time.

The production of finished steel of all kinds in France last year was 655,086 tons, as compared with 638,530 tons in 1891.

The mining engineers of the South-West Africa Company announce the discovery in the company's territory of an extensive outcrop of copper ore a few miles north of the Otavi mines in Damaraland.

At Messrs. Colville's Dalziel Steel Works, Motherwell, Scotland, one of the large plate mills recently turned out 460 tons of finished plates in 24 hours. This is said to be the largest output of plates ever known in Scotland.

Messrs. Needham Brothers, of Barnsley, have recently successfully cast two 18ft. pulley-wheels for the Cubody colliery, Conisborough, which will be used for coal winding. The pulleys are made to carry four decked cages, two corves in each deck, which will bring to the surface four tons of coal at a time.

The Old Lodge Tinplate Company, Llanelly, is about to lay down two additional mills at the Old Lodge Works, making eight in all. Since the resumption of operations, after a long idleness, a few months ago, the works have been very busy, and quite recently, owing to the pressure, it was found necessary to set a couple of newly-erected mills in motion. A proposal for the erection of new steelworks in connection with the establishment is now under consideration.

The exports of cutlery from Sheffield to the United States for the past quarter amounted in value to the sum of £28,436, an increase of £5000 as compared with the corresponding period of last year. Notwithstanding this improvement, the cutlery trade is still 50 per cent. below the volume of trade done before the M'Kinley tariff came into operation. The value for 1889 and 1890 exceeded £50,000 for the first three months of the year.

The return of the Cleveland Ironmasters' Association for the month of March shows an increase of stocks of Cleveland iron of 10,000 tons, with 88 furnaces in blast—one less than in February. There was a total production of 235,000 tons of pig iron, nearly 25,000 tons more than in February, March being longer. Hematite and basic iron stood for 111,000 tons, the remainder being Cleveland brands. The return is more encouraging, as during the previous three months stocks increased 110,000 tons. There are 194,000 tons in stock.

New Companies.

SAFETY MINING AND BLASTING SYNDICATE LIMITED.—This syndicate was registered on the 29th ult., with a capital of £4000, in £1 shares, to acquire and work a new departure in blasting in mines and quarries, known as Macnab's Patent, to enter into two agreements, and to make explosives for this purpose. Registered, without articles of association, by H. F. McDowell, 4, Chancery-lane, W.C.

STOCKTON HEATH FORGE COMPANY LIMITED.—This company was registered on the 5th inst., with a capital of £15,000, in £10 shares, to acquire and afterwards carry on the business now carried on under the style of the Stockton Heath Forge Company, at Stockton Heath, within Appleton, Cheshire, and to follow the trade of makers of forgings of every description, cycle manufacturers, and mechanical engineers. A good many of the rules of Table A apply. Registered by Cole and Jackson, 25, Essex-street, W.C.

INDESTRUCTIBLE IGNITION TUBE SYNDICATE LIMITED.—This company was registered on the 30th ult., with a capital of £4500, in £1 shares, to purchase any patents and licences relating to any invention which the company may think it advisable to use for its purposes, to adopt a certain agreement, and to carry on the business of mechanical and general engineers, manufacturers of gas engines, printing and other machinery. The number of directors is not to be less than 2, nor more than 5; qualification not stated: remuneration, £100 per annum. Registered by Colyer and Colyer, 41, Wych-street, Strand, W.C.

DOMESTIC TELEPHONE COMPANY LIMITED.—This company was registered on the 4th inst., with a capital of £20,000, in 3990 ordinary or "A" and 10 management or "B" shares, all of £5 each, for the entering into and carrying out an agreement with Sir Charles Stewart Forbes, Bart., for the making of several inventions, and the carrying on of the businesses of a telephone company and exchange, electrical engineers, and manufacturers of all kinds of electrical, telephonic, or magnetic appliances. The number of directors is not to be less than 3, nor more than 7, the first being Sir C. S. Forbes, Bart., Hon. J. Mansfield, Hon. Claude Hay, L. T. Fitzgibbon, and T. D. Croft. It is not necessary for a director to hold any shares in the company. Registered by Ingram, Harrison and Ingram, 67, Lincoln's Inn Fields, W.C.

The Metal Market.

PRICES CURRENT.

LONDON, April 10.

COPPER began 3s. 9d. lower, three months passing at £45 6s. 3d., and £45 5s. was shortly taken. Cash followed at £44 16s. 3d., and May dates, both early and late, were sold at £45, while later on middle May was done at £44 18s. 9d. Afternoon trading covered three months at £45 3s. 9d., and on the kerb £44 15s. was taken

for cash, the close being easy and 6s. 3d. lower on the day. The decline is due to realisation induced by weaker Paris advices and the prevailing depression in financial circles. Sales, 600 tons. Settlement price, £44 15s. Strong sheets, £56 10s. to £57; English tough, £48; best selected, £49 5s. to £49 10s.

TIN opened firm, and cash was simultaneously placed at £93 12s. 6d. and £93 10s. Subsequently, with renewed speculative interest, all the year in seller's option made £88, and three months gained 10s. at £91. Cash offerings were light, and with prominent support prices advanced to £94 5s. for the beginning and end of May, and to £94 for prompt delivery, the market ruling firm throughout, and closing 10s. better on the day. A small quantity of cash sold at £93 17s. 6d., but there were further buyers at the price. Sales, 80 tons. Settlement price, £94. English ingots, £97.

PIG IRON opened steady at 40s. 10½d. cash, and with a better demand prices hardened throughout, 14 days making 41s. 0½d., cash 40s. 11½d., and one month 41s 2d. Towards the close 41s. was paid for cash in a week, and 41s. 7d. for three months, Scotch closing steadily at about 1d. advance. Sales, 4000 tons. Settlement price:—Scotch, 40s. 11d.; Middlesbrough, 34s. 5d.; hematite, 45s. 6d.

TINPLATES quiet, but steady. I.C. cokes, f.o.b. London, 12s. 9d; Liverpool, 12s. 3d.; Swansea, 11s. 9d.

LEAD is quiet, at £9 15s. to £9 16s. 3d. English, £10.

SPELTER firm and unchanged. April-May shipment, £17 15s. sellers.

ZINC SHEET.—Silesian are 2s. 6d. better, in sympathy with spelter, at £20 17s. 6d. to £21 ex ship. Belgian firm; V.M. brand, £20 17s. 6d. ex ship, and £20 15s. f.o.b. Antwerp.

OFFICIAL CLOSING QUOTATIONS.

	To-day. £ s. d. £ s. d.
COPPER—	
G. M. B.—Cash	44 16 3—45 13 9
" Three months	45 3 9—45 11 3
TIN—	
Fine foreign—Cash	94 0 0—94 10 0
" " Three months	91 0 0—91 10 0
Australian—Cash	94 15 0—95 5 0
PIG IRON—	s. d.
Scotch warrants—Cash	40 11½
" One month	41 1½
Middlesbrough—Cash	34 5
" One month	34 7
Hematite—Cash	45 6
" One month	—

GLASGOW, April 10.—Business was very idle on the pig iron market, and only 2500 tons of Scotch changed hands during the day at 40s. 10½d. to 40s. 11½d. cash, sellers remaining at the best. The tone at the finish was steady, but reports as to the general trade afforded no encouragement. Cleveland was marked 1d. on the day. The shipments of Scotch iron last week total 5425 tons—a decrease from the corresponding week of 3184 tons, thus making the decrease for the year to date 3614 tons.

QUOTATIONS:—

	Scotch. Cash. s. d.	Scotch. 1 m'th. s. d.	Middlesbrough. Cash. s. d.	Middlesbrough. 1 m'th. s. d.	Hematite. Cash. s. d.	Hematite. 1 m'th. s. d.
Highest	40 11½	41 1½	34 5	34 7	45 7	—
Lowest	40 10½	41 1½	34 5	34 7	45 6	—
Close	40 11	41 1½	34 5	34 7	45 6	—
Prev. close	40 10½	41 1	34 5	34 7	45 7½	45 9½

Official Gazette.

Partnerships Dissolved.

F. REID and W. NICHOL, electrical engineers, Newcastle-upon-Tyne, under the style of F. Reid, Nichol and Co.

V. G. BEARDSHAW, W. BEARDSHAW, E. T. BEARDSHAW, and W. F. BEARDSHAW, merchants and manufacturers of steel, saws, files, steel goods, and other articles of hardware, Attercliffe, Sheffield, under the style of Jonathan Beardshaw and Son, as far as regards V. G. Beardshaw and W. Beardshaw.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Order made on Application for Discharge.

ARTHUR ABERCROMBIE (trading as Abercrombie and Son), Whitfield-street, Tottenham Court-road, W., county of London, and Balham Park-road, S.W., brass founder and finisher. Discharge granted.

Receiving Order.

D. M. DAVIES AND CO., colliery and mill furnishers and iron and steel merchants.

Letters to the Editor.

We do not hold ourselves responsible for opinions expressed by correspondents.

The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.

Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

AVOIDANCE OF SMOKE.

To the Editor of THE MECHANICAL WORLD.

SIR,—In answer to "W.'s" question I beg to say that I have a letter from the people who are using gas for heating their boilers, telling me they save £480 a year on the pair of boilers working night and day, that they have never ceased their use since they started them eighteen months ago, and that the plant shows no sign of needing repair. This does not look much like doubt or danger. In fact, there is no danger; the economy is well proved, and nothing prevents the extension of the system but the same shortsightedness that scoffed at railways when they were first projected.

Mr. Walker can answer his own question if he asks himself how gas can do the same work as coal in the same time, without giving the same horse-power. If he had read my letters carefully, he would not have needed to inquire on such a point.

I have certainly given facts enough to convince anyone with an open mind, and it is useless to write for others. This letter must, therefore, be my last, but I will answer any letter if stamped envelope be sent for reply. T. NICHOLSON.

Colwyn Bay, April 10.

Miscellaneous Items.

Gutta-percha was first introduced into Europe from Malaga in 1852. The annual consumption now amounts to 4,000,000lb.

The Leith Dock Commissioners have decided to construct a dry dock to the south of the Prince of Wales Graving Dock. The new dock will be 285ft. by 74ft., and the estimated cost is £40,000.

The electric light has been introduced on a few of the trains of the Great Northern Railway of Ireland, travelling between Dublin and Drogheda. The dynamo is placed in the guard's van and is driven from the axle.

The equipment of a number of omnibuses with an incandescent lamp, fed from secondary batteries placed under the driver's seat, has proved so successful that all the omnibuses of the two largest companies in London will shortly be fitted in that manner.

The weight of a million sovereigns, newly minted, is 10 tons, 14cwt. 15lb. A million pounds' worth of fresh-coined silver pieces of British money weighs over 151 tons 10cwt. These enormous weights and value may be represented by a few pounds of banknotes. It takes 512 notes to weigh 1lb.

There is a 10-ton yacht now being built in a yard on the Loire which is said to be the first sea-going vessel ever made of aluminium. The employment of aluminium makes the weight of the hull of the 10-ton cutter in question 2500kilos. instead of 4500kilos., as it would be if made of the usual composite.

The Government of India has decided to exclude liquid carbonic-acid gas, when secured in wrought-iron cylinders tested to a pressure of 250 atmospheres, from the list of dangerous goods scheduled under the Railway Act. This will enable the manufacturers of this commodity, which is now being used for a variety of purposes, to greatly develop their trade, and to carry on their business at a profit.

In addition to the large amount already expended in the deepening of the Medway, between Chatham and Sheerness, a further sum of £12,000 is taken in this year's estimates to enable dredging operations to be continued. When these are completed a channel will be obtained of sufficient depth to enable the largest armoured vessels to leave Chatham for sea, with the whole of their guns and their other weights on board.

The big lifting bridge over the Harlem river, on the New York Central and Hudson River Railroad, was recently successfully moved to a point some 60ft. west of its original location. The moving of the great tower (127ft. high and weighing 180 tons) was actually completed in 21min.; but the preparations for the work occupied several days. The removal was made necessary by the fact that a new bridge will have to be built in connection with the raising of the tracks across the Harlem.

Mr. Clement Stretton, the author of "The Locomotive and its Development," observes that we often hear of a speed of 90 or 100 miles an hour being reached, but for 25 years he has ridden upon many engines and travelled in all the fastest trains upon all the railways in this country, for the special purpose of ascertaining their rate of speed. Upon a few occasions, and under favourable circumstances, he has recorded the very high speed of 79·9 miles an hour, but Mr. Stretton states that he has never been able to time a train or engine at actually 80 miles an hour.

The first of a series of important armour-plate experiments took place on the 7th inst., at Portsmouth, on board the "Nettle," a plate cast by John Brown and Co., of Sheffield, and treated by Tressider process, being tried. Five rounds were fired from a 6in. gun, the charges ranging from 36lb. to 42lb., with the result that four shots penetrated, but made clean holes, which could easily be plugged. The first shot, a Holtzer, with 36lb. charge, broke on impact. One fired with a 42lb. charge penetrated the bulkhead of the "Nettle," as well as the backing. Numbers three, four, and five lodged in the backing, the two last being Pallisers.

In Switzerland there is now being manufactured a glass brick, or a brown building block, formed or moulded flask shape with short neck at each end, 8in. in length, 6in. in width, and 2½in. in depth, with an air-chamber through the centre. The edges of the brick are covered, recessed, or ribbed and grooved to receive, when laid, a suitable cement of plastic material of such character that after it has hardened it will constitute a suitable frame or setting to keep the entire mass, roof or wall solidly together. The forms or moulds, there being two different shapes, are pleasing to the eye, the lines or ridges being clean and smooth, and of a sufficient thickness or strength to stand a pressure of 150lb. to 200lb. to the square foot.

A curious industry has lately arisen in the Punjab. Large quantities of kerosene are imported from Russia and America, and the tin cases containing the oil are sold cheaply when empty, and eagerly purchased by the whitesmith, who manufactures from them a number of articles, both fancy and useful. Packing cases, which frequently arrive from Europe with tin linings, are also utilised in the same way.

The death is announced at New York, on the 1st inst., of General Berdan, the inventor of the well-known rifle which bears his name. He was the pioneer of the modern magazine rifle, although his weapon was more of the nature of a repeater. It carries all the cartridges under the barrel, and in all other respects may be said to be an ordinary bolt rifle. The Russian Army is the only European power armed at the present day with the Berdan rifle; but even here a new one will shortly be adopted, as the Berdan is not found to answer the modern requirements.

Queries.

Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

ENGINE PACKING.—Required the makers of the Britannia engine packing.—L. HULL.

BRIGHTENING CHAINS.—Can any correspondent inform me what material to use in a shaker to brighten chains?—W. B.

WOOD'S AUTOMATIC PRESSURE RELIEF VALVE.—Required the address of Mr. W. Wood, the maker of the above.—B. AND CO.

COST OF M.S. AND L. RAILWAY.—Can anyone inform me what was the cost per mile of the M.S. and L. Railway from Manchester to Grimsby?—LOW DROP

LOCOMOTIVE STAY TAPS.—Can any reader furnish me with the addresses of firms who are makers of locomotive stay taps suitable for fireboxes?—GEORGE.

METALLIC PAPER.—Could any reader inform me how paper can be prepared for taking indicator diagrams upon, with brass or iron point, to give a clear erasure with the slightest pressure?—M. H. M.

RUST JOINTS.—How can I stop leakage in a vertical joint (rust joint) in my hot-water pipes (low-pressure system) without cutting out the packing? Would any fluid cement percolate into the crevices and harden there? —B.

POWER RENTAL.—I am desirous of supplying steam power to a tenant from an engine driving his own works. How is the value of such to be ascertained, and what is the fair price for 100I.H.P. per week of 54 hours; also for 8I.H.P. similarly supplied power?

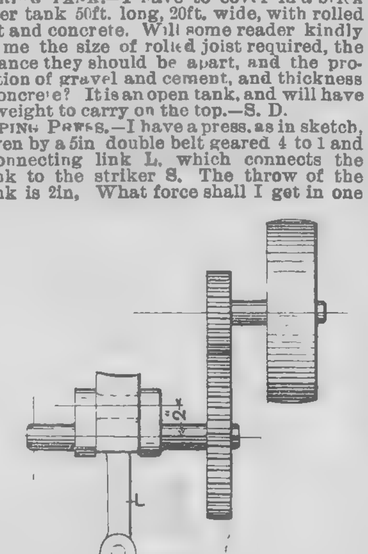
STEAM REVERSING GEAR.—I should be much obliged if any reader will explain the working of a steam reversing gear for locomotives, which I have seen on the following railway companies' engines:—Glasgow and South-Western, Mersey Tunnel, and South-Eastern. A sketch would assist me.—F. TURTON.

TUBBING.—What system ought to be adopted in the renewal of tubbing in a shaft which has become faulty in the middle of a length of tubbing 25 fathoms from the surface—pit 15ft. and 100 fathoms deep? Kindly explain what method to use to secure the greatest safety and make the most permanent work.—J. M.

METALLURGICAL FURNACE.—Can any reader furnish me with a scheme for supplying the heating power necessary for a metallurgical laboratory situated in iron-ore mining district, and where no gas is available? A small muffle furnace would be required, in addition to the ordinary heating power, and the fuel used is charcoal. Accommodation only required for one chemist.—H. S.

COVERING TANK.—I have to cover in a brick water tank 50ft. long, 20ft. wide, with rolled joist and concrete. Will some reader kindly tell me the size of rolled joist required, the distance they should be apart, and the proportion of gravel and cement, and thickness of concrete? It is an open tank, and will have no weight to carry on the top.—S. D.

STAMPING PRESS.—I have a press, as in sketch, driven by a 5in double belt geared 4 to 1 and a connecting link L, which connects the crank to the striker S. The throw of the crank is 2in. What force shall I get in one



blow on the table A, and how shall I calculate the force if a fly-wheel is added, say 3ft. diameter and weighing 300lb? The thickness of the material to be stamped is $\frac{1}{16}$in., the depth about 3in., and the area of stamp 400sq. in.—YOUNG DRAUGHTSMAN.

FACING SLIDE VALVE FACES.—I require a hand appliance, not expensive, suitable for getting up the faces of slide valves of portable, traction, and other engines, say when the valve face is some 3in. to 4in. from the valve-chest cover face. Are there no small hand-lever appliances which can be screwed on to a stud and used for working a broken file or similar tool?—NESCIENCE.

Replies.

Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

S. STOWE.—We can supply the books named.

LUCIFER (Hull).—Sampson and Co., Stroud, Gloucester.

COCHE-.—A letter to the office of the journals in Paris will find them.

J. O.—Your query is not quite clear. Do you mean to drive the dynamo at twice the speed?

SORE LIPS.—Electro-plating is the only satisfactory remedy. You can get this done in almost any large town for a few pence.

NOVICE.—(1.) There is no small work on the subject. Consult Pamely's "Colliery Manager's Handbook." (2.) Donaldson's "Sketching for Marine Engineers." (3.) March 8, 1890.

TRANSVAAL.—We do not think your present training will be of much service to you in South Africa. There are no books published on repair work, so that we are unable to assist you.

G. ETHELL.—It is possible theoretically, but it would be exceedingly difficult in practice to, effect such a nice adjustment. In any case the load and the speed would require to be absolutely constant.

W. M. S.—Brazing is effected by using brass spelter and powdered borax, moistened with water. Lay this mixture on the joint, place the job over a clear fire, and gently urge the latter until the brass "runs" into the joint.

W. P.—We do not know the particular method adopted by the firm named. Possibly the following, from Brannt's "Metal Workers' Handy-book," will suit you:—First slightly heat it over a gas or other flame and rub it all over with a mixture of castile soap and lampblack. This is to prevent the edges from being burnt. The next is to get a thick iron pipe 2in. in diameter and ¾in. bore. This is well filled up with taps or dies and charcoal dust, the ends being closed with clay as before; this is placed in the furnace and occasionally turned until it is one uniform heat of cherry-red or on the outside a trifle hotter. It is then carefully removed from the fire, one end of the clay is knocked off, and the contents are allowed to drop perpendicularly into a solution of water, chloride of sodium and nitrate of iron; this solution is kept at a temperature of 60° F. The articles to be hardened should remain at least a quarter of an hour before being removed. This method of hardening may be summed up thus: Make the steel of one grain throughout, prevent it from oxidising whilst being heated, allow every part to heat at the same time, avoid bending while hot, and, lastly, restore if possible by replacing the loss of carbon caused by heating.

ABYSSINIAN PUMP.—Will any reader give me a description of an Abyssinian pump and some information of the same?—T. SMITH.——*A.*—A description of the Abyssinian pump may be had of the Isle of Axholme Tube Well Company, Crowle, Doncaster.

RAIL CROSSINGS.—Given the gauge and the angle of crossing of rails, what rule is generally adopted to obtain the radius of the curve and the rails?—R. A. J.——*A.*—If angle of crossing = A and gauge = G, then

$$A^2 \times (G \times 2) + \frac{G}{2} = \text{radius of outer rail when}$$

leaving a straight road.—MARTIN WELLS.

PUMPING PLANT.—Thanks to Mr. Hopkins for reply regarding pumping plant. Would he kindly say what he thinks would be the cost per day to do the same amount of work with oil engine of, say, best make?—J. P.——*A.*—In reply to J. P., I beg to inform him that the cost of an oil engine for the work would be about ¾d. per horse-power per hour, when using oil at 5d. per gallon. The engine I would fix is the Priestman's, which has a four-cycle movement—that is, the piston on its forward stroke draws in a charge. This charge is compressed on the second stroke, and at the moment of compression an electric spark from a small battery explodes the charge and drives the piston out, thus making the third stroke. The fourth stroke drives the spent vapour out of the cylinder through an exhaust valve.—D. HOPKINS.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed

25th March 1893.

*6393 AUTOMATIC VALVE for REGULATING the SUPPLY of COMPRESSED GASES to HOLDERS. H Steinem and W Cook.

6397 MOTIVE POWER MACHINE WORKED by SPRINGS and AIR. L Wake.

6407 LAMP and SHADE HOLDER for INCANDESCENT LAMPS. H L Todd and F Lake.

6408 APPARATUS for COOLING or HEATING AIR and OTHER GASES. J F Jones.

27th March, 1893.

6416 PACKING RING for GAUGE GLASSES on BOILERS. C Barclay.

6417 APPARATUS for WORKING AUTOMATIC DAMPERS or MECHANICAL STOKERS. W H Scott and W Reavell.

6418 CINDER SIFTER and FUEL ECONOMISER. G Rider.
6420 MEANS to PREVENT the VIBRATION of CARRIAGE WINDOWS. A Harvie.
6423 PURIFICATION of SEWAGE. J J and T F Meldrum.
6425 HOLDER for WATCHMAKERS' and GRAVERS' TOOLS. A G and G V Pinfold.
6428 APPARATUS for PLACING DETONATORS on TOP of the RAILS for SIGNALLING TRAINS. R Platt.
6439 ELECTRIC SWITCHES. T E Marsh and T G Poole.
6443 SELF-ACTING FUNNEL DAMPER for MARINE BOILERS. J A Smith.
6444 AIR PUMPS. G M Cruikshank. (*Seaville Manufacturing Company*, United States.)
6445 MULTIPLE STEAM JET NOZZLE. W A Granger.
6446 APPARATUS for SHOWING the PHENOMENA of the EXPANSION of CRYSTALS by HEAT PRODUCED by ELECTRIC FORCE. J Swift.
6447 CONNECTING FLEXIBLE PIPES to a TAP or VALVE, ADAPTED to RAILWAY CARRIAGE HEATING. T J Davis.
6453 INTERNAL COMBUSTION ENGINES. J C R Okes.
6461 APPARATUS for HEATING or COOLING and VENTILATING BUILDINGS. C G Norris and G H Richmond.
6463 AQUA AMMONIA ENGINES. C L Horack.
6464 THRUST SHAFTS or SHAFTS SUBJECT to END PRESSURE. E Reynolds.
6465 SELF-ACTING APPARATUS for RAISING or FORCING LIQUID by STEAM or COMPRESSED AIR. P Kestner.
6468 ELECTRIC ARC LAMPS.* Siemens, Brothers and Co. Limited and J Nebell.
6469 FIRE ESCAPE or APPARATUS for USE in DESCENDING from the WINDOWS and ROOFS of BUILDINGS. G W Thomas.
6470 ELECTRICAL MEASURING INSTRUMENTS. B J B Mills. (*A E Kennelly*, United States.)
6475 APPARATUS for VARYING the SPEED of ELECTRO-MOTORS or the ELECTRO-MOTIVE FORCE of ELECTRO-DYNAMOS. J J Rickards.
6478 DYNAMO-ELECTRIC MACHINES.* E Thomson.
6479 METHOD of ROLLING WHEELS or DISCS. J Kleinpeter.

28th March, 1893.

6489 ELECTRIC ALARM in SIGNAL BOXES, WHEREBY RAILWAY COLLISIONS MAY BE AVOIDED. G C Purvis.
6496 SELF-ALIGNING or SWIVEL-BEARING for SHAFTS or JOURNALS. A G Barrett and W Newton.
6497 FASTENING or SECURING of DOORS to GAS and OTHER KINDS of RETORTS or FURNACES. J Gill.
6498 APPARATUS for HOLDING TWIST DRILLS. R Lang.
6506 ANTI-DIP VALVES, EMPLOYED in the MANUFACTURE of GAS. W Cross.
6507 FEED-WATER PURIFYING APPARATUS for STEAM BOILERS. R W B Sanderson.
6511 METALLIC SPRINGS. G Hookham.
6512 HOISTING and TRANSFER APPARATUS.* W D Sherman.
6513 MACHINE for CUTTING FILES AUTOMATICALLY. A F Denison.
6515 CONSUMPTION of SMOKE and WASTE GASES in FURNACES. E Smith.
6528 ARMATURES. J G Statter.
6530 PNEUMATIC BRAKE SYSTEMS.* W C Whitacre.
6531 TRAIN PIPE VALVES for PNEUMATIC BRAKE SYSTEMS. W C Whitacre.
6532 APPARATUS for RECORDING EXCESS CURRENTS in the WORKING of ELECTROMOTORS. G Kapp.
6534 GAS and OIL ENGINES. H Berk.
6536 MECHANICAL APPLIANCES for OPENING and CLOSING HEAVY LIDS or COVERS, SUCH AS for VERTICAL HEATING FURNACES.* F W Dick.
6541 APPARATUS for CUTTING GLASS. L Havaux.
6545 APPARATUS for CONNECTING MECHANICAL POWER CIRCUITS for TRANSMITTING POWER for HAULAGE in MINES. W Hopwood.
6546 COMPUTING APPARATUS.* K E Wiberg and G F Berndes.
6547 VENTILATORS. H L Hansen and W Walker.
6548 DRYING APPARATUS.* L M Larsson and C J Bergström.
6550 STATION INDICATORS for RAILWAY TRAINS and STEAMBOATS. D Paterson and L Percheron.
6551 PYRO-ELECTRIC GENERATOR.* T G Hall.
6555 DEVICES for COMMUNICATING MOTION.* L Warfield.
6557 HIDE-WORKING CYLINDERS.* H H Lake. (*A E Whitney*, United States.)
6558 CYLINDERS and VALVES for STEAM ENGINES.* H H Lake. (*H R Fay*, United States.)
6559 ELECTRIC HEATING APPARATUS.* M W Dewey.
6562 POWER-DRIVEN TOOL.* F H Cathcart.
6564 COMPOSITIONS for SELF-LUBRICATING BEARINGS.* O Imray. (*J F Newell*, United States.)
6565 DRY VOLTAIC CELLS.* Siemens, Brothers and Co. Limited and E F A Obach.
6568 PERCUSSIVE TOOL OPERATED by FLUID PRESSURE, APPLICABLE as a ROCK DRILL.* W White and J F C Snell.
6573 VOLT METERS.* F Brown.
6574 CIGAR-MAKING MACHINES.* A C Schutz and N H Borgfeldt.
6575 RAILWAYS and RAILWAY ROLLING STOCK. T E W Fay.
6577 PORTABLE APPARATUS for TURNING, FACING, CUTTING and SCREWING PIPES and TUBES. W Wright.
6579 ELECTRICALLY-HEATED RADIATOR.* W Mitchell.
6580 SIGNAL WHISTLE. W M Smouse.
6581 GUIDE-HOLDER for STAMP MILLS. P C Robertson.

29th March, 1893.

6589 VENTILATORS. D Donald and J Sime.
6590 SELF-CALCULATING MICROMETER GAUGES and CALIPERS. J C Smith.
6604 FEED-WATER HEATER for the UTILISATION of EXHAUST STEAM. J G Williams.
6605 DIAPHRAGMS for USE in ELECTROLYTIC PROCESSES. E T Parker.
6610 FUEL ECONOMISERS for STEAM BOILERS. J T Turner.
6613 STREET BOXES for CONTAINING TRANSFORMERS USED in ELECTRICAL DISTRIBUTION. The Hon C A Parsons and J B Willis.
6615 SHIP'S PROPELLER. T Marshall.
6621 CONNECTING LINKS for CHAINS. E J Tonks and G Spencer.
6626 AUTOMATIC VALVULAR DEVICE for SUPPLYING STEAM, WATER or OTHER FLUIDS. J Apsey.
6627 WORKING of RAILWAY SIGNALS and POINTS by ELECTRICITY. I A Timmis.
6628 INSULATOR PINS or STANDARDS.* F M Locke and others.
6629 BALL VALVES. P D Manning and J F Andrews.
6631 DEVICE for HOLDING LATHE CUTTERS and OTHER TOOLS in POSITION. W F Beardshaw.
6633 PAPER-CUTTING MACHINES. W Crosland.
6637 APPLICATION of ELECTRICITY to CLOSED CARRIAGES. F W Golby. (*A Casella, jun.*, France.)
6641 VICES. H Thomas.
6642 SECURING the SOCKET SHANK of INCANDESCENT LAMPS. D Mather and J Kemp-Welch.
6646 BLOCK SIGNALLING APPARATUS. F T Hollins.
6648 RAILWAY and TRAMWAY LOCOMOTIVES. J J D Cleminson.
6649 TELEPHONE TRANSMITTERS. G A Nussbaum.
6651 CHAIN-GEAR WHEELS. T Clifton.
6654 ELECTRIC BELLS. E F Terrey.
6655 PYROMETERS.* A J Boult. (*E Brown*, United States.)
6662 MANUFACTURE from VEGETABLE SUBSTANCES of PRODUCTS for MAKING BOILER COMPOSITIONS or FLUIDS. J Miles.
6666 DISTRIBUTION of ELECTRICITY. W Geipel.
6667 SCREW THREADS. E T Lambert.
6671 ELECTRO-METALLURGY of ZINC. S O Cowper-Coles.
6672 TOOL for CUTTING TAPERING APERTURES. R Quinn.
6676 PNEUMATIC TYRES. W R Foster.

30th March, 1893.

6677 RAILWAY ELECTRICAL SIGNALLING DEVICES. W Grimes.
6680 SPEED INDICATORS. W Chadburn.
6684 LIGHTING and EXTINGUISHING ATTACHMENTS for ELECTRIC and GAS LAMPS. H L Muller and W Adkins.
6687 LATHES for SCREWING, TURNING, and FACING VARIOUS ARTICLES. J H Stone and S W Hughes.
6688 UTILISING the HEATED GASES from REFUSE DESTRUCTOR FURNACES. B D Healey.
6692 WATER TUYERE for BLAST FURNACES. J Parker.
6697 HEATING of GASES by ELECTRICITY. W Donaldson.
6699 UTILISATION of STEAM for MOTIVE POWER and HEATING. J Murrie.
6700 COUPLING for FLEXIBLE PIPES. J B Cook.
6702 DYNAMO BRUSHES.* K Koch.
6708 PROCESS and COMPOSITION for POLISHING WOOD. F Sator.
6713 INDICATORS for INDICATING the NAMES of STATIONS or STOPPING PLACES on RAILWAYS or TRAMWAYS. W C Betts and A S Jackson.
6715 INSTRUMENTS for DRILLING or BORING ROCK or METAL. O Terp and others.
6721 STEAM GENERATORS. G Zahikian.
6723 COATINGS or COVERINGS for ELECTRIC CONDUCTORS. C T Snedekor.
6729 FURNACES. T R Swaine and T Harrison.
6735 LIGHTING INCANDESCENT GAS LAMPS. W P Thomson. (*R Schlesinger*, Germany.)
6743 APPARATUS for PURIFYING SEWAGE EFFLUENTS by MEANS of OXYGEN. F Fanta.
6748 FEEDING "SLABS" or "BLOOMS" to ROLLING MILLS.* F W Dick.
6754 THERMOSTATS.* H S Tunnard and A M Keays.
6755 COUPLINGS for RODS. A G Evans.
6758 CENTRIFUGAL VENTILATING FANS.* C Herscher.
6759 MACHINERY for PRESSING BOATS from SHEET METAL. W Heslop.
6762 HYDRAULIC LIFTS. J S Stevens and C G Major.
6765 VICES.* G Glasson.
6770 APPARATUS for DRYING PEAT. J D Brunton.
6774 COOLING of WATER for EXPLOSION ENGINES. R Edwards.
6776 THE LINING of KILNS and FURNACES. D L Collins.
6780 SECONDARY BATTERIES. V C Doubleday. (*M Sussmann*, Germany.)
6782 INSTRUMENT for MEASURING DISTANCES and RESOLVING TRIGONOMETRICAL PROBLEMS. E Falletti.
6783 AIR-VALVE MECHANISM for WATER MAINS. G G M Hardingham. (*C T Pollit*, Australia.)
6785 APPARATUS for FEEDING CARBONS in ELECTRIC ARC LAMPS. F Hallows.
6786 APPLIANCES in CONNECTION with MINING OPERATIONS. W Charlton.
6787 SLIDE VALVES. T Crawford.
6788 FURNACE ATTACHMENT for HANDLING of FIRING TOOLS. T Das and J E Slack.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to SIR H. READER LACK, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

All who are practically engaged in Mechanical Engineering or Scientific Industries are invited to avail themselves of THE MECHANICAL WORLD columns for information. We are glad to help the diffident, and, so far as we can, remove the obstacles which frequently prevent practical men from communicating their ideas.

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FRIDAY, APRIL 21ST, 1893.

The Engines of the "Campania."

THE departure from Liverpool to-morrow of the new Cunard steamship "Campania" marks a new era in the history of the Atlantic passenger service, for, judging from the vessel's performance on her trial trips, she should bring the record for the transatlantic passage down to within measurable distance of a five days' voyage. Surprise has been expressed in some quarters that quadruple-expansion engines were not adopted; but, taking all things into consideration, we are inclined to think that the Fairfield Company have done wisely in retaining the triple engine for the service. For pressures under 200lb. per square inch, quadruple expansion is at best a doubtful expedient so far as economy is concerned. Messrs. Cramp have, we believe, decided to use quadruple engines in the new steamers which they are now building for the American Line, the pressure being 210lb. per square inch. These builders anticipate a saving of fuel of 10 per cent. over triple engines of equal power. That this saving will be realised is, we think, very doubtful indeed; but doubtless the performance of the new American vessels will be watched with interest by the builders of the "Campania." The engines of the latter vessel are calculated to give collectively 30,000I.H.P. They consist of two separate sets of inverted-cylinder engines, each set having five cylinders—two high, one intermediate, and two low-pressure—which work on to three cranks set at angles of 120° from each other. Each high-pressure cylinder is placed upon one of the low-pressure cylinders, forming a pair of tandem engines, one on each side of the intermediate. The high-pressure pair are fitted with piston valves, and the intermediate and low-pressure with three double-ported slide valves, all of which are worked by the usual double eccentrics and link motion gear. The high-pressure cylinders are 37in. in diameter; the intermediates, 79in.; and the low-pressures, 98in. in diameter. The stroke is 69in.; the normal speed, 81 revolutions per minute; and the boiler pressure, 165lb. per square inch. The crankshaft is 26in. in diameter, and each of the three interchangeable parts weighs 27 tons. These, with the thrust shaft, 14ft. long, make up a total of 110 tons for each crankshaft. The propeller shaft is 24in. in diameter, and is fitted in lengths of 24ft., each length having two bearings. Each thrust block is fitted with 14 rings. The propellers, which are placed on the ends of the shafts without any exterior overhanging bracket, are three-bladed, and weigh 48 tons in all. Steam is supplied by 12 double-ended boilers, 18ft. in diameter and 17ft. long, having four furnaces in each end. There are also two smaller boilers, which may either be set apart for pumps, electric lighting, and other auxiliary work, or joined with the other 12 for the purposes of propulsion. One of these is 18ft. in diameter and 11ft. long, with four furnaces; and the other 10ft. in diameter and 10ft. long, with two furnaces. These boilers are made of unusually large steel plates, 20ft. by 7ft. and $1\frac{7}{16}$in. thick. They have been tested to a pressure of 330lb. per square inch, and have, all told, 102 furnaces. They are, as almost everything in the boat is, the largest yet made, and they produce the pressure required without forced draught. The coal consumption is said to be as low as 1·5lb. per horse-power per hour, as compared with 1·9lb. in the case of the "Umbria." For circulating the condensing water, four large centrifugal pumps are employed, driven by independent compound engines, which may also, if necessary, be used for ordinary pumping purposes. There are also four evaporators; a large feed-water heater; two auxiliary condensers, with pumps; and other economising and labour-saving appliances. The electric installation consists of four sets of generating plant, each set consisting of a Siemens dynamo, coupled direct to a Belliss engine, which runs at 280 revolutions a minute. This is capable of supplying 1350 16C.P. incandescent lights, including eight large lights, for working cargo throughout the ship, and a powerful search light.

Lighting of the City.

THE hopes expressed last week by Sir David Salomons, chairman of the City of London Electric Lighting Company, as to the future prospects of the undertaking for the electrical illumination of the City of London, were no doubt very sanguine, and may possibly be realised. Lighting operations by the present company were only actually commenced in June of last year, the previous few months having been occupied in testing under continuous running the first plant delivered by the contractors. Experience, we all know well, teaches us a great deal—it teaches us not only what to perform properly, but also what to avoid. The experience gained by the London Electric Supply Corporation—the pioneer enterprise of its kind—has been bought dearly, and has been of incalculable benefit to the City and other electric-light undertakings. It has taught them, at least, one very important fact—namely, that the policy of constructing gigantic works at the beginning, and of equipping them with plant far beyond the possible requirements for light for several years, is very injudicious. It taught them, too, that the better plan was to build and equip generating stations capable of dealing with present and possible future requirements, on a moderate scale, and with ample scope for laying down additional plant to cope with extensions at any future time. Sir David fully appreciated this fact when he mentioned that the London Electric Supply Corporation had a history, and that in creating it they had paid penalties which the City Electric Lighting Company had endeavoured to avoid. It must not be inferred from this that the lighting of the City is a small enterprise—it is really a very important undertaking. At first, it was intended to have two generating stations, one at Bankside and the other at Wool Quay. The latter has never actually been built, as it would have been expensive to construct, equip and maintain, and, owing to its low level, pumping operations would doubtless have had to be carried on day and night to keep the water out of the station. Thus the whole of the plant will be concentrated at Bankside, where, erected by the Brush Company, and acquired by the City Company, the pioneer station is at work. The Bankside site covers a large area of ground which extends back from the river front a distance of 511ft. The station is a model one, but it will be eclipsed by the works now being built around it. At the end of last year, the number of 8C.P. lamps connected to the mains was 20,250, and since then the total has been brought up to 38,200 lamps. It is scarcely possible at present to meet the demand for light, and it was only by laying down two large half-units to assist the pioneer station that the additional number of lamps supplied this year could be lighted. Operations are, however, being expedited which, by the end of the year, are expected to allow of the supply of 130,000 lamps. For this purpose some very large alternators are being made in this country, one of which has already given good results under a long test, whilst two large alternators are being built in the States, and are shortly expected to arrive at Bankside. The public illumination of the streets by arc lamps is practically complete; every main thoroughfare is lighted, the total length of streets lighted is eleven miles, and the number of arc lamps in operation is 409. Work is now proceeding for the lighting of the side streets by incandescent lamps, two streets being already equipped for the approval of the City Commission of Sewers. The Bankside permanent station is being built in a systematic manner. It is being constructed in sections, one of which is complete and at work. The second section is in progress, and others will be added and equipped as required. The public lighting is carried on at a loss, but this may not always be the case. It may, perhaps, be considered as a negligable item, as the company has a monopoly of electric lighting in the City, whilst the income from private consumers is steadily increasing. The prospects of the undertaking, which is only now getting into working order, are hopeful, and in a year hence, with the present increasing demand for light, this young enterprise will be supplying as many lights as any other concern in the metropolis.

Foreign Plant in France.

THE French national pride is sorely wounded by the course events have taken during the past few years in the electrical industries in that country. Generally speaking, native genius, when it has departed from theory, has only undertaken the production of electrical machinery and the carrying out of electrical work on a small scale as compared with some other countries, and the result is that in some of the largest enterprises foreign plant is either made or used. As far as lighting is concerned, there are at Paris, working important districts, foreign concerns, such as the Edison Company, the Popp Company, and the Alsatian Company of Mechanical Constructions, using Siemens plant, whilst at Havre Ferranti alternators are employed. In the case, however, of manufacturing, the four largest engineering and metallurgical works in France construct electrical plant under foreign patents. The great Creusot works build the machinery and apparatus for Ganz and Co., of Buda-Pesth; the Compagnie de Fives-Lille, those of the General Electricity Company of Berlin; the Etablissements Cail, the Berthoud-Borel cables; and the Societé Alsacienne de Constructions Mecaniques make the plant of Siemens and Halske, of Berlin. This state of affairs is partly attributed by a French journal to the protective tariffs of France. That may or may not be the case, but it is significant that in heavy electrical engineering, appliances made under foreign patents take a leading position in France; and the efforts of the legislature in endeavouring to stop foreign plant, especially at the frontier, have been foiled by the existing tariffs.

Traction and Telephony.

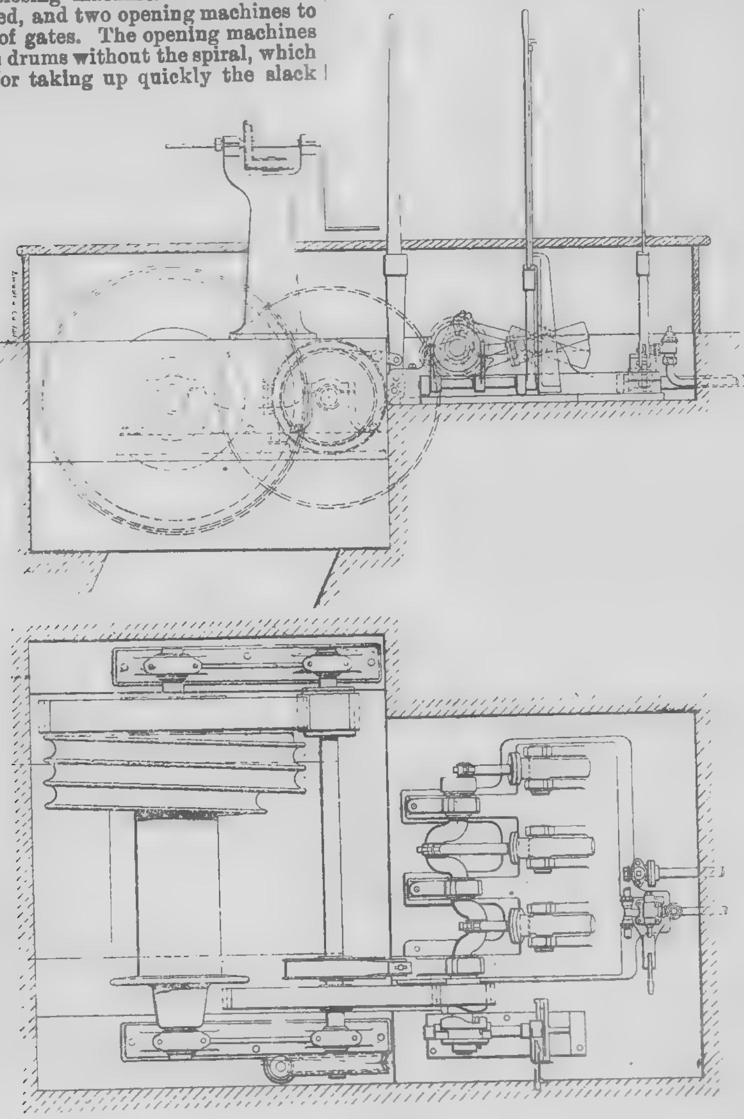
IN a paper read last week before the Tramways Institute at Liverpool, Mr. Sellon drew attention to the objectionable attitude adopted by the National Telephone Company towards tramway companies who ask Parliament for powers to introduce electric traction. The telephone company have been endeavouring to get inserted in all tramway bills clauses protecting them in the event of electricity being adopted as the motive power, they being advised by their engineer that the laying down of a line on the single-trolley system would disturb the working of the telephones by induction in the wires. Induction may be set up in the telephone wires through the proximity of such a tramway, but the root of the evil lies in the use by the telephone company of a single wire, with the earth as the return, instead of employing double wire or a metallic circuit. The double-wire system has been introduced in all progressive countries where the telephone service has been rendered very efficient. On the other hand, the National Telephone Company, by the use and extension of the single-wire system, have afforded a poor service, which is at the same time expensive. Whatever disturbance may be caused in wires adjacent to an electric tramway, as in the case of Leeds, is really due to the use of single wires, and such induction would not occur if twin wires were used, as they ought to be. It is absurd that tramway companies should be required, as the telephone company seem to desire, to contribute towards the cost of improving their system, and the formation of the Electric Traction Association to combat the demands of the telephone company is a step in the right direction. Let us hope that the efforts of the association will be successful; but in the meantime it is somewhat poor consolation to find in the metropolis, where an underground double-wire system was promised, that the telephone company are doubling their overhead wires.

The German Basic Steel Industry.

THERE are signs that the manufacture of basic steel in Germany is likely to develop considerably during the next few years. Already the largest producers of basic steel in the world, the German manufacturers will undoubtedly derive considerable advantage from the early lapsing of the Thomas-Gilchrist patents, and also by reason of the great reduction on the carriage of iron ore from Luxemburg and Lothringen to the blast furnaces of Westphalia. This latter item will be sufficient to reduce the cost of producing basic pig iron fully 4s. per ton, and of steel in proportion.

Hydraulic Machinery.—XIV.

FIGS. 41, 42 and 43 show three types of dock-gate machines in common use. Fig. 41 is an ordinary crab, geared to a three-cylinder oscillating engine. It is arranged with clutch gear, so that in running off the slack chain the engine can be thrown out of gear and the machine worked by the brake. A hand gear is also provided for use in case the hydraulic power from any reason should not be available. The figure shows a closing machine. Two of these are required, and two opening machines to each pair of gates. The opening machines have plain drums without the spiral, which is added for taking up quickly the slack slack chain, and also provided with a balance weight for returning the ram. Angle chainways and roller boxes are required, as shown. The rollers are usually chilled, and are arranged so as to be readily unshipped by a diver and new ones put in. In some cases the roller box is designed so that it can be hauled up the angle chainway out of the water and the rollers changed; but as this method entails considerable extra expense in the masonry work, it is not very often adopted.



HYDRAULIC MACHINERY.—FIG. 41.

chain required for the closing machine. Angle chainways and roller boxes are required for this type of machine.

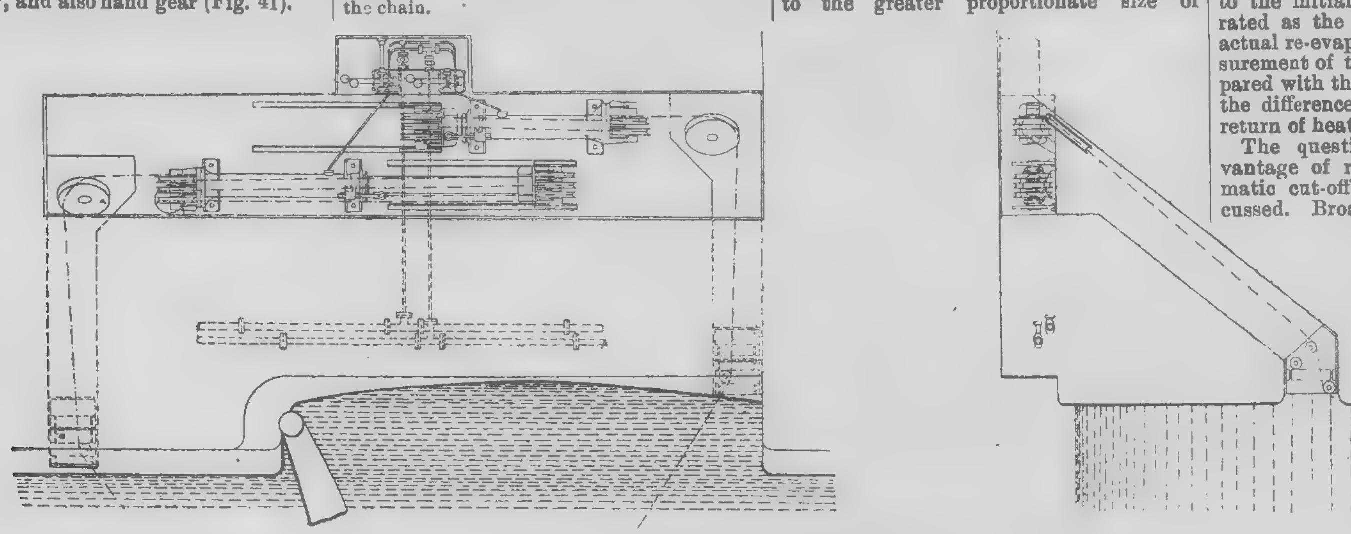
Fig. 42 is the Elswick gate machine, cup drums being substituted for the barrels, and the angle chainways and roller boxes dispensed with. The chains lead along the top of the gate and down by suitable sheaves and brackets secured to the gate to the bottom of the lock, and thence to the fast ends secured in the masonry. Only two of these machines are required for each pair of gates. Suitable clutch and brake gear is provided to work each drum independently, and also hand gear (Fig. 41).

The power required to work the gates depends on the width of entrance, the depth of water on the sill, the construction of the gate itself and of the roller path, and on the situation. It is very difficult, therefore, to give a rule which would meet all cases. The following are a few of the sizes from actual practice:—

65ft. entrance, 28ft. of water on the sill, 12½in. diameter cylinders, 6 to 1 multiplying power, 750lb. average pressure.

50ft. entrance, 28ft. of water on sill, 12in. diameter cylinders, 6 to 1 multiplying power, 700lb. average pressure.

50ft. entrance, 28ft. of water on sill, geared machine, arranged to exert a pull of 3½ tons on the chain.



HYDRAULIC MACHINERY.—FIG. 43.

Fig. 43 shows a half plan of hydraulic cylinders, with multiplying sheaves for working a pair of gates—being part of the installation fitted by Messrs. Abbot and Co. Limited for King's Lynn docks. Four cylinders are required, two for opening and two for closing, the latter being made with extra stroke to take up or let down the

50ft. entrance, 31ft. 6in. of water on sill, geared machine, arranged to exert 4 tons on the chain.

A novel departure has been made at Barry Dock, where a double-acting cylinder is fitted on trunnions, and exerts a direct pull or thrust on the gates in moving them.

(*To be continued.*)

Steam-engine Trials.

AT the ordinary meeting of the Institution of Civil Engineers, held on Tuesday, the 11th inst., Mr. Harrison Hayter, president, in the chair, a paper was read giving a detailed account of the last series of "Steam-engine Trials" undertaken by the late Mr. P. W. Willans, M.Inst.C.E.

The paper dealt with an extensive series of condensing trials made with a 40I.H.P. Willans central-valve engine. These were intended to form a sequel to the investigations described in the author's papers entitled "Economy Trials of a Non-condensing Steam Engine, Simple, Compound, and Triple," read before the Institution in 1888 and 1889. The principal objects in undertaking these trials were: (1) To ascertain the initial condensation in the first cylinder, and to trace the behaviour of the steam in the succeeding cylinders, when working as a compound or triple-expansion engine; (2) To observe the effect of speed of rotation, area of exposed surface, and range of temperature, upon the initial condensation, and upon economy generally; (3) To ascertain the percentage of the theoretical mean pressure actually obtained; (4) To ascertain the ratio of the work done by each pound of steam to the theoretical work due from it; (5) To determine the consumption of steam at all loads, and under various conditions.

The consumption of steam was determined by discharging the condensed water from the exhaust into a tank carried by a weigh-bridge, and observing the intervals of time required for fixed weights of water to run in. By this method, a continual watch was kept on the performance of the engine during the whole trial, and any disturbing cause was immediately detected; leaky steam-pipe joints did not affect the result, and the length of the trial might be much reduced. Special experiments, made to ascertain whether any addition was necessary to cover leakage in the engine and exhaust pipe, showed that this leakage was slight.

The method of determining the theoretical work due from 1lb. of saturated steam when discharging into a condenser was next considered, and it was shown that the thermal efficiency of a condensing engine must of necessity be less than that of a non-condensing engine, owing to the greater proportionate size of the "toe" of the diagram cut off for practical reasons. In the non-condensing trials the best number of expansions was computed from the approximate formula $p^9\ v^7 = \text{constant}$; but for the condensing trials the error in this could not be neglected. The best ratios of expansion and mean pressure were therefore calculated for adiabatic expansion by Mr. McFarlane Gray's $\theta\ \phi$ diagram, combined with a volume curve. Altogether 62 trials were made under various conditions of speed, steam pressure, load, and ratio of expansion, as well as with the engine working simple, compound and triple, and the results were embodied in the tables accompanying the paper.

One of the principal deductions from these experiments was the "straight-line" law of steam consumption; and it was shown by diagrams that the total water for the horse-power corresponding to any mean

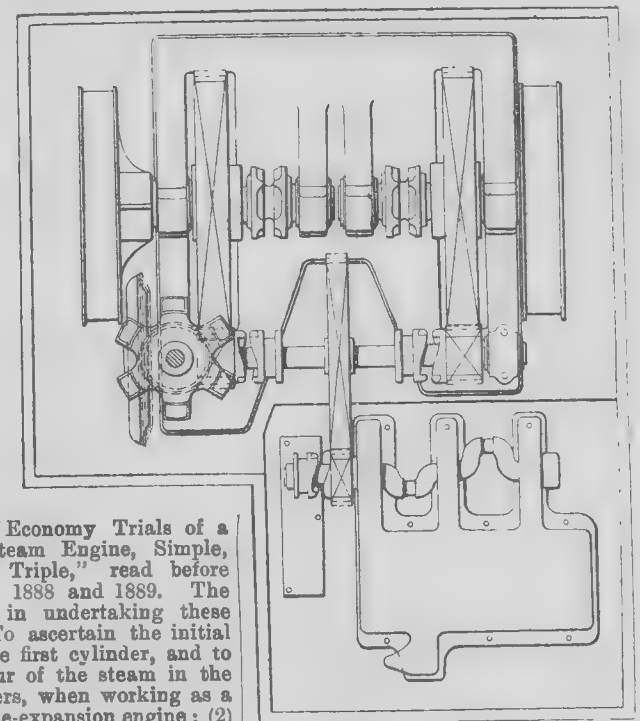


FIG. 42.

pressure P, was W+K P, where W was the water which would be used by the engine at zero mean pressure (through initial condensation, radiation and conduction), supposing it were frictionless, and K was the water per hour required to produce each pound of mean pressure. These factors were shown to vary with the conditions under which the engine was working.

Eighteen of the trials were planned to assist in determining the law connecting initial condensation with revolutions; and it was found that in the high-pressure cylinder at high mean pressures the total condensation per unit of time was directly proportional to the square root of the number of revolutions per unit of time. As the mean pressure was diminished, the condensation became more and more nearly constant at all speeds; and, finally, at low mean pressures the law appeared to be reversed. For the low-pressure cylinder the law was modified.

The important question of the changing proportions of steam and water present during the expansive part of the stroke was investigated by the $\theta\ \phi$ diagram. The matter was first examined theoretically by considering the effect of a thin liner of infinitely conducting matter, and a curve was drawn on the $\theta\ \phi$ diagram showing the rate at which the steam initially condensed in warming up the liner from the exhaust to the initial temperature was re-evaporated as the expansion proceeded. The actual re-evaporation, as obtained by measurement of the indicator cards, was compared with this theoretical re-evaporation, the difference measuring the delay in the return of heat from the liner to the steam.

The question of the economical advantage of reducing the power by automatic cut-off *versus* throttling was discussed. Broadly, the result was that the gain by varying the expansion was large for a simple engine, moderate for a compound engine, and, for a triple engine, almost inappreciable. The gain at high speeds was greater than at low speeds.

A few trials made with the cylinders steam-jacketed showed a slight gain, but further experiments were required to show

whether the gain was likely to be worth the extra trouble and expense involved.

The missing steam at cut-off varied in the trials to even a greater extent than it did in the non-condensing trials — the amount being much affected by the range of temperature, the density of the steam, etc.

It appeared that, under all circumstances, the triple-condensing engine showed an advantage over the compound in regard to steam consumption; but that, except for very large engines, the compound-transfer engine was probably the best for pressures below 150lb. (absolute) pressure per square inch.

The Design and Construction of Stationary Engines.—LII.

FIG. 221 shows sectional plan and elevation of the crankshaft bearings of the Astley Mill engines, built by Mr. B. Goodfellow, of Hyde. The engines are of the horizontal compound receiver type, having cylinders 32in. and 60in. diameter by 7ft. stroke, running 50 revolutions per minute, and indicating 1300H.P. with a boiler pressure of 100lb. The flywheel is a rope pulley 34ft. diameter, and weighs about 80 tons. The necks are 17in. diameter by 40in. long, and the steps are made in four parts with horizontal joints, the side steps being adjustable back and front by two wedges having a bearing between the inside of the pedestal body and the tapered sides of the steps. The wedges are worked up or down by a central screw passing through the cap, with a large collar on the underside to take the thrust of the wedge, and fitted with a locking nut outside of the cap. The steps are arranged so that by lifting the shaft ½in. they can all be removed. Each pedestal is supplied with an improved valveless pump attached to an oil reservoir forming part of the steps at the back of the pedestal. The lubricant is forced up to a branch pipe over the pedestal cap, which is fitted with cocks for regulating the flow of oil. The return oil is collected in troughs at each side of the pedestal, from which it passes back to the reservoir, after being filtered through screens of wire gauze to remove the dust, etc., and is then used again, thus economising the use of oil. M. I. Farcot, of Saint Ouen, France, exhibited at the late Paris Exhibition a Corliss engine having pedestals of a somewhat unusual description, and which are shown in Figs. 222 and 223. In the former it will be seen that the lower surfaces of the side brasses are portions of a cylinder, having a diameter equal to the width of the opening between the guiding surfaces and as the shaft lowers through wear, the side brasses are enabled to maintain their full bearing by canting over. Two screws having spherical ends press against a spherical cavity in the side block, which can thus move with the brass, while the latter is free to slide on its front surface. Fig. 223 shows an alternative arrangement similar in principle, but provided with a loose oiling ring.

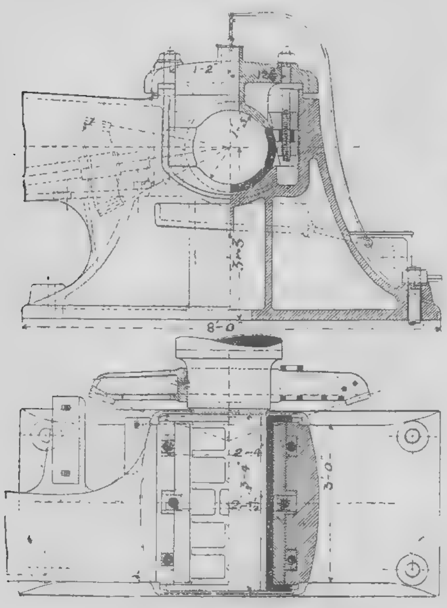
Fig. 224 shows a pedestal end for Corliss trunk frames of Continental design. For the following particulars respecting these we are indebted to the "Machine Constructor." The bearings are made in four pieces, and the front part of bearing is set up by means of double steel set screws, working through round steel nuts let into recesses in the frames. These nuts are prevented from turning by the insertion of mall pins. The set screws are provided with lock nuts to prevent the side bearings from being unduly pressed against the shaft by any turning of the set screws from vibration. The screws are made with square threads.

When the crankshaft is to be placed in the bearing, the side portions are moved back as far as the space occupied by the loose liners will permit for the easy introduction of the shaft, and afterwards brought together again. The space left between the side bearings and the pedestal shell only requires to be of such width as to allow the bearings to be slipped round the shaft. If the side bearing is to be lifted out vertically, this space must be made greater, and made up by steel packing plates X. For the easy removal of the parts of the bearings, holes are tapped in them into which eye bolts can be screwed for lifting out.

When the side bearings get considerably worn, thicker steel plates have to be put in to take the place of the original ones.

The bearings are made of cast iron, lined with white metal. The recesses in the cast-iron shells are dovetailed lengthwise and crosswise to hold the metal well. In the larger sizes of engines the recesses are turned in the shells, which permits of an even layer of metal being let in all round, and of a relatively less thickness.

The cast-iron shells are made hexagonal in shape, and provided with chipping strips, which allow of them being well fitted into the frame. No flanges are provided for these shells, but the bottom one has a strong lug or boss, well fitted into a hole provided for it in the pedestal, which prevents any movement endwise. The collar on the crankshaft and the crank boss prevent the other portions from moving out of place. The bearing is bored out after the parts have been fitted into the frame in place. After boring, the bearing is scraped a good fit to the shaft in the usual way.



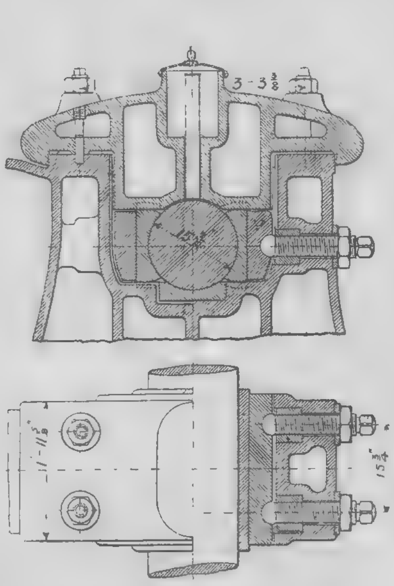
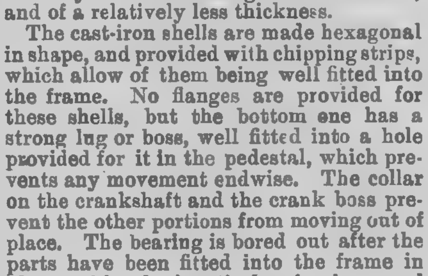


FIG. 221.—DESIGN, ETC., OF STATIONARY ENGINES.—FIG. 222.



STATIONARY ENGINES.—FIG. 223.

The surfaces of the top and bottom bearings have to be well machined and finished, so that they rest perfectly on the shell, to prevent the oil from running through the joints. In horizontal engines having this form of bearing there is no vertical stress on the pedestal covers; but, to withstand any sudden stresses or shocks, it must be strongly designed, and have side flanges or lips fitting over the ends of the pedestal proper. The cover is held down by four bolts with square heads, fitting into cored holes in the pedestal. Oil should always be used for lubrication, as solid greases or fats are more suited to small bearings. To catch the waste and surplus oil, cups or pockets Y are cast on the frame. Loose oil collectors, screwed or pinned on, are not only more expensive, but difficult to keep tight.

(To be continued.)

Testing and Analysis of Iron and Steel.—XIV.

BY MESSRS. LEADBEATER AND HODGSON (*Analytical Chemists*).

Determination of Combined Carbon.—The samples of steel from the converter or Siemens furnace are usually brought into the laboratory whilst still hot, and any effort to cool them, by plunging the sample into cold water, would so harden the steel that it would be impossible to touch it with a drill. Consequently they must be allowed to cool slowly, or, in cases of urgency, they may be dipped into hot water mixed with a little soft soap, which cools without hardening them.

The drillings should be very fine and free from dust and oil. Exactly 0·1grm. of the drillings are weighed out and placed in a clean and perfectly dry test tube.

The standard steel drillings are now taken; 0·1grm. is weighed out and introduced into another test tube of similar size and shape.

The amount of carbon in the standard steel is previously determined by the combustion methods before described. Several determinations are made with the same steel, and the mean of the results taken as the correct one. The whole of the drillings are then bottled, labelled and kept perfectly dry for future use.

To the two test tubes—the one containing the steel under examination, and the other the standard—are added 2cc. of nitric acid, prepared by diluting pure nitric acid with distilled water until the specific gravity is 1·2. The tubes are shaken a little, and as soon as the first violence of the reaction is over they are placed in a beaker half-filled with boiling water. The beaker is placed on a hot plate in order to keep up the temperature, and they are allowed to remain—frequently agitating them—until the last traces of iron are dissolved. When this is effected the tubes are removed and allowed to cool slowly.

Two graduated tubes about the same diameter as the test tubes, and holding about 10cc. divided into 0·1cc., are taken and well cleaned. The two solutions from the test tubes are decanted into the graduated tubes, care being taken to notice the one in which the standard is placed. If any residue remains in either test tube a few drops of nitric acid are added to both tubes, although one may contain no residue, and both are replaced in the beaker for a little time. If no further action is seen to take place between the residue and the nitric acid, it may be assumed to be silica or graphite. A little water is then added, and the contents of the test tubes are introduced into their respective graduated tube along with the first portions.

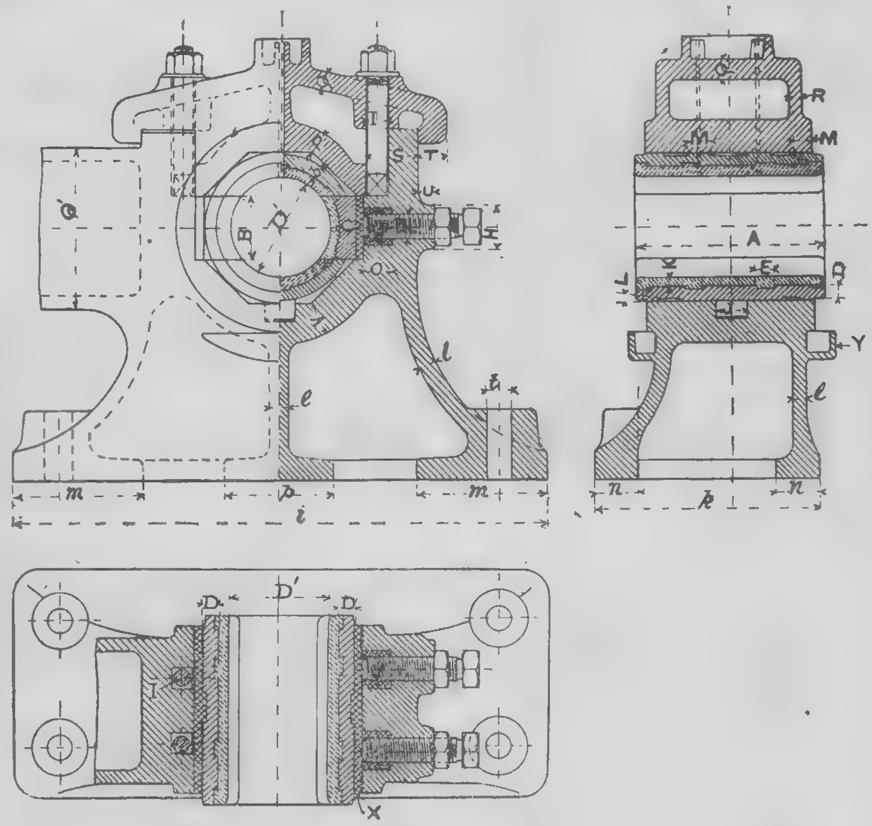
It must be borne in mind that whatever is done to the standard solution before the comparison, must also be done in like manner to the solution under examination, and *vice versâ*.

Suppose now the standard steel taken was previously found by combustion to contain 0·58 per cent. of carbon, then the brown-coloured liquid which was prepared from the standard steel and placed in the graduated tube must be diluted with nitric acid water until it occupies 5·8cc. as measured by the graduations. The brown colour will thereby be reduced in intensity, but will still be of a very decided tint.

The brown solution prepared from the steel under examination is next diluted with nitric acid water until it is of exactly the same tint as the standard, the two tubes being held side by side with a piece of clean filter paper at the back for comparison. When exactly the same tint has been obtained, the graduations which mark the level of the liquid in the second tube are read off. Supposing 6·2, then dividing by 10, we get 0·62, which is the percentage of combined carbon contained in the sample under examination.

The final addition of water to the sample, in order to make the tints exactly alike, is a rather delicate matter, but with a little practice it can be easily done.

When the combined carbon is present in very small quantities the colour of the solution is very faint, and great difficulty is found in matching them. The following method is recommended:—1grm. of steel is dissolved in 12cc. of nitric acid, specific gravity 1·2, at a temperature a little below boiling. After all action ceases a few cubic centimetres of hot water are added and 13cc. of a solution of sodium hydrate, specific gravity 1·27. The liquid is diluted with hot water and allowed to stand for a quarter of an hour. A sample being prepared and treated in exactly the same manner, the two are then filtered through dry filter papers and compared as above in graduated tubes. The colouring matter, when dissolved by the soda, is much more intense than in an acid solution, so that it can be much more readily seen.



DESIGN, ETC., OF STATIONARY ENGINES.—FIG. 224.

Estimation of Manganese.—About 5grms. of the pig iron or steel are dissolved in hydrochloric acid, with the subsequent addition of strong nitric acid. The solution is evaporated to dryness in the usual manner to render silica insoluble. After cooling, strong hydrochloric acid is again added, and the solution evaporated to dryness.

Hydrochloric acid is added, and then boiling water, and the whole passed through a filter paper into a litre flask, the siliceous residue being well washed on the filter, which, of course, after drying, igniting, and weighing, will give the amount of silica as before described. The liquid in the flask is diluted to about half-a-litre, and a solution of ammonium carbonate added in small portions at a time until the solution is nearly neutral.

The flask is now placed on a hot plate and made to boil for a short time. A little more dilute ammonium carbonate is added until there is a slight precipitate formed which is just redissolved on shaking. Now add a few drops of acetic acid, followed by a solution of ammonium acetate. The

flask is now heated and made to boil, and kept at this temperature for some time. Large flakes of ferric acetate should now begin to fall and settle rapidly, leaving the liquid quite clear. If the liquid above the ferric acetate is coloured or has any finely-divided precipitate, it should be thrown away and a fresh start made, as it is useless to proceed further if the ferric acetate has come down in that form. Some experience is necessary in getting the proper form of precipitate which will filter rapidly; the finely-divided form only fills up the pores of the filter paper and prevents the rest of the liquid passing through. When the precipitate appears to be complete, and the ferric acetate, which is of a fine red colour, has settled down to the bottom of the flask, the solution is passed through a large filter paper into another flask of similar capacity. When all the liquid has passed through into the second flask, the funnel containing the filter paper and precipitate is removed, and placed over the original flask in which the precipitation was first made. Hot strong hydrochloric acid is passed through the filter until all the precipitate is dissolved, and the solution has run into the flask below; the filter is washed with boiling water until all traces of acid are removed. The solution of the ferric acetate in the first flask is neutralised with ammonium carbonate, and reprecipitated with ammonium acetate in an exactly similar manner to that described above. The solution is then filtered into flask No. 2, and allowed to mix with the liquid from the first filtration. If the sample under treatment is ferro-manganese or spiegeleisen, the operation must be repeated three or four times. The object is to remove all the iron from the solution, and leave the manganese in the filtrate. If, however, the sample contains much manganese, a considerable quantity is carried down along with the iron precipitate, and the final result is too low.

If any quantity of manganese is still retained in the ferric acetate the brick-red colour changes to dark brown on exposure to the atmosphere, owing to the oxide of manganese absorbing oxygen and becoming changed into a darker colour.

The mixed filtrates are heated, and when warm about 2cc. of bromine are added from a test tube. This must be done in the stench closet. The exact quantity required varies, but enough must be added to render the liquid of a deep-red colour. The liquid is heated nearly to boiling, and an excess of ammonium hydrate added in the stench closet. The liquid is violently shaken, and then boiled for some time, when the black precipitate of manganese will settle to the bottom.

It is filtered off on as small a filter as possible, well washed, dried, ignited, and weighed.

The composition of the precipitate is MnO_2, its molecular weight—

Mn	55
O_2	32
	87

Suppose the amount of MnO_2, less the amount of ash, to be 0·005grm., and the amount of steel taken to be 1grm. Then the amount of manganese will be as follows:—

$$\frac{0{\cdot}005 \times 55}{87} = 0{\cdot}0031,$$

and the percentage of manganese is

$$\frac{0{\cdot}0031 \times 100}{1} = 0{\cdot}31 \text{ per cent.}$$

(*To be continued.*)

Scale in Steam Boilers.

[CONTRIBUTED.]

It is, of course, self-evident that all the deposits, hard or soft, which are found in boilers are brought in by and abstracted from the water which enters the boiler. The materials forming these deposits may, however, be present in the water in various forms, and the abstraction of these materials may take place in various ways.

These substances, then, may be in suspension in the water, or may be in solution. Water from ponds or canals is an instance of the former case. Here we have minute particles of mud and other substances simply floating in the water, and these are so minute and so light that as long as the water is even slightly in motion they are kept suspended, like a feather in a high wind. If the water is kept absolutely at rest, however, for a sufficient time, these particles sink to the bottom, and the water becomes clear. This method of clarifying water, however, is not generally practicable, as the storage space and area of settling tank would be too great. Muddy water should, therefore, always be filtered before it is admitted as feed-water. This may be done either by a large sand filter on the principle of the ordinary waterworks filter, or by one of the many patent "self-cleansing" filters now in vogue, which occupy less space, and are easily cleaned.

The effect of admitting muddy water to a steam boiler is two-fold. The mud may settle on the bottom of a boiler which is not externally fired or flued, and which is, therefore, comparatively cold in those places, and there form simply a deposit of more or less soft mud, which can easily be cleared away. This kind of deposit is found in locomotive boilers, where the mud settles below the level of the firebars, and often stands a considerable height in the space between the internal and external fireboxes. To wash out this deposit the "wash-out plugs" are fitted at the lower angles of the firebox outer shell. In Lancashire boilers, also, such a deposit is often found in great quantity lying along the bottom of the boiler shell. The reason that the solid matter brought into the boiler by the water is not carried out by the steam is simply that, steam being so much lighter than water, a particle will not float in the one which will float in the other; in fact, the case is precisely similar to that of a piece of wood which falls down through the air, but on falling into a pond of water descends no farther. While admitting this general principle, however, we must allow for the exceptions—one of which is that as most boilers prime to a greater or less extent, the suspended substances may, and often do, go over in the priming water, and find their way into valve chests, pipes, and cylinders in this manner, greatly to the detriment of the finished surfaces. Another exception to the rule of steam leaving extraneous particles behind is in the case of fatty and some other substances, which are themselves capable of vaporisation and so go over with the steam as vapour, getting condensed later on and so choking valve ports and steam passages. Troublesome as the choking of passages in the cylinders is, this is not the only trouble or the worst that oil and grease in the water causes. Grease may cause: (1) priming, (2) overheating, (3) corrosion. Grease is supposed to cause priming by lying on the surface of the water and preventing the free and regular escape of steam from the surface. Melted tallow or oil is sometimes, however, injected into small vertical boilers to *prevent* priming, on the supposition that it will act as "oil on the troubled waters" and so keep down the violent ebullition which no doubt is a cause of priming. So that of the precise method of action of oil or grease in causing priming we cannot be said to be perfectly cognisant, but there is no doubt that the presence of grease in a boiler does often bring about such an effect. Grease may cause overheating by combining with the particles of mud or carbonate of lime (of which more anon) and so forming a spongy mass of incrustation which clings to the plates, being too compacted together and too sticky to be removed by the ebullition around it, and through its high non-conducting properties preventing the plates giving off their heat to the water. Again, grease may cause corrosion in the form of "pitting." This is ascribed to the decomposition of the grease by excessive temperature of the water or plates with which the grease comes in contact. This decomposition results in the formation of an acid which attacks the plates of the shell, and eats out holes in them. For these reasons above stated various attempts have been made to keep grease out of the boiler, or neutralise its effects when unavoidably present.

It is usual, especially in marine-engine practice, to use a special oil called "cylinder oil," of various brands, which does not decompose into fatty acid, and which does not cling round and insulate the condenser tubes. Soda is also often fed into the boiler where fatty or other acids are present. Being an alkali, it combines with and neutralises the acids forming a base. A "soda cock" is sometimes fitted to the exhaust pipe of surface-condensing engines, with the object of neutralising the acids in and mixing with the water in the hotwell, whence it is pumped into the boiler with the feed. The amount of soda used, however, should be carefully regulated to the requirements, as it is liable to cause priming if used in excess. The usual quantity used varies from 1lb. to $2\frac{1}{2}$lb. per day.

So great difficulty has the presence of fatty acids sometimes caused in surface-condensing engines, where the same water is used over and over again, that the surface-condensing apparatus has even had to be removed to give place to an ordinary jet condenser, notwithstanding the loss of economy likely to be felt owing to the substitution.

So much for substances in suspension, and grease. Now we come to a more prolific and unavoidable source of scale—viz., the mineral matters *in solution*. Such are sulphate of lime, bicarbonate of lime and carbonate of magnesia. Most waters contain some of these substances dissolved in them, like sugar is dissolved in water, and they cannot be extracted by any amount of filtering or mechanical treatment. Unfortunately, these particular substances are more soluble in cold than in hot water; in fact, whereas the cold water may contain a very large amount of them, when raised to the boiling point it is incapable of retaining in solution any at all; hence, immediately the water is injected into the boiler, these substances are precipitated and fall down on to the quietest place they can find in the boiler. While steam is up, however, and rapid ebullition and circulation by convection currents are in progress, the precipitate continues in the main to float about, and it is only at night or when the boiler is at rest that they settle completely. Then next morning, when the fires are urged again, the stratum of mineral matter is baked on to the plates, whence it is not able again to raise itself. In this way layer after layer is formed, and in a shorter time with fairly pure water, and a longer with highly-charged water, a thick crust is compacted all over the boiler.

The following are the weights of different salts which 1 imperial gallon of water is capable of holding in solution when cold and when at boiling point:—

—	At 60°.	At 212°.
Carbonate of lime	Merely traces.	Merely traces.
Silica	70grs.	,,
Sulphate of lime	175 ,,	,,
Carbonate of magnesia	3·25oz.	,,
Chloride of sodium ..	32oz.	32oz.
Chloride of calcium ..	540oz.	Unlimited.

For the prevention of the incrustation there are several methods, such as blowing-off, feeding chemical reagents into the boiler, and softening the water previous to its introduction into the boiler.

The placing of the blow-off cock is an important and not easily-settled matter. Generally, in stationary-engine boilers the blow-off is simply at the lowest possible place in the boiler, so as to collect the settled precipitate. If this is done the pipe in the boiler should be extended its whole length, so as to take the precipitate out equally all along. Scum cocks also are often fitted so as to remove the often-floating scum compounded of froth, grease, small pieces of rubbish, etc., which find their way into the boiler through the feed. The great difficulty with scum cocks is to get them at exactly the right height below the surface of the water. Floating arrangements have been introduced to effect this, but perhaps the surest practical device is simply to fix the scum cock at a known height below the pointer on the gauge glass, and then wait until the water is the right height by the glass before blowing off. It is needless to say that the blowing out of a large amount of hot water is an appreciable waste of good energy; but until a completely efficient and practical device is brought out, blowing-off no doubt will continue to be exercised.

Of chemical substances used to make the precipitate more soluble, the most universal is common soda or carbonate of soda. The effect of this is to allow a soft, easily-washed out sludge to fall and remain on the bottom of the boiler instead of allowing the ordinary hard scale to crust on. It will be noticed that once the water is introduced all its contents must there remain, while the water itself passes off and makes room for more; so that a frequent opening and washing-out of the boiler is absolutely necessary.

A method, however, which is gaining ground nowadays, is the purification of the water before its introduction to the boiler. This may be done by the well-known Clarke's process, which in the main consists in mixing lime water (quicklime dissolved in pure water) with the water supply, and then filtering the resultant. Such a method is by far the most satisfactory and scientific, and it is to be hoped will eventually become universal in steam-boiler practice.

Messrs. William Denny and Brothers, Dumbarton, have received an order to build a steamer of 5000 tons deadweight for the Rangoon trade of Messrs. P. Henderson and Co.

State of the Skilled Labour Market.

The following memorandum has been prepared for the "Board of Trade Journal" by the Labour Correspondent to the Board of Trade:—

The number of strikes that have commenced during the month is somewhat larger than usual, no less than 59 having been reported, against 37 last month and 39 in the corresponding period of 1892. Of these 22 occurred in connection with mining, 12 in the building trades, 5 were due to disputes in the shipping and dock industry, 4 arose in the shipbuilding trade, 4 were in the textile trades, the remainder being spread over various other trades and industries. In 25 of these strikes a total of 10,056 persons were engaged, the majority of the others being of short duration, and involving the displacement of but a comparatively small proportion of labour. The settlement of the cotton dispute during the month has enabled a very considerable number of workers to resume employment not only in the textile, but in various subsidiary industries more or less affected by the lock-out. The termination of this dispute has not, however, affected the number of unemployed in this important industry for the period under review, not having taken place in time to make any material alteration in the figures for the month, though there is evidence to show that but for the lock-out, trade, so far as the number of unemployed is concerned, might have been reported as "moderate." Taken as a whole, the demand for labour during the month may be generally described as steady, with in some cases an upward tendency, though still below the average for the time of year, as is evidenced by the fact that in April, 1890, the proportion of unemployed was 1·7, in 1891 2·8, in 1892 5·7, and in April of this year 8·70. This is largely due to the falling-off in the engineering and iron trades, which the improvement in the building trades has not been sufficient to counteract, while the metropolitan printing trade, which last month was reported slack, has rapidly got worse, and thus swelled the number of unemployed by 664. Of the 23 unions from which returns have been received, 12 describe trade as bad, 6 moderate, and 5 good, a very slight variation, as will be seen, from last month's report. The membership of these unions is found to be 294,136, of which number 25,622 are unemployed, a net decrease for the month of 890. The percentage for the month is 8·7, compared with 9·5 for the previous month.

Shipbuilding Notes.

The Peninsular and Oriental Company have contracted for a large new steamer of 7500 tons and 11,000H.P. with Messrs. Caird and Co., of Greenock.

Messrs. Robert Duncan and Co., Port-Glasgow, launched on the 3rd inst. a four-masted steel barque of 2000 tons register, to carry 3600 tons of cargo, of the following dimensions:—Length, 270ft.; breadth, 42ft.; depth, 24ft. 6in.

Messrs. Rodgers and Co., Port-Glasgow, have now completed the important extensions which have for some time past been in progress at their shipbuilding yard. The alterations will greatly facilitate the working of the establishment in the future.

Messrs. Wood, Skinner and Co. launched from their shipbuilding yard at Bill Quay, on the 7th inst., a steel screw steamer of the following dimensions:—Length, 214ft.; beam, 30ft.; depth, moulded, 16ft.; with a deadweight carrying capacity of about 1300 tons. Her engines are of the triple-expansion type, and have been built at the works of the North-Eastern Marine Engineering Company, Wallsend. They have cylinders 17in., 28in., and 46in. diameter, with a piston stroke of 30in., and are supplied with steam by a large steel boiler working at a pressure of 160lb. per sq. in.

On the 17th inst. Messrs. Wm. Gray and Co. Limited launched the steel screw-steamer "Elax," the fourth of the steamers they are building for Messrs. Samuel and Co., of London, for the bulk petroleum trade to the East through the Suez Canal. Her dimensions are:—Length over all, 358ft.; breadth extreme, 45ft. 6in.; depth, 28ft. 6in. Two powerful pumps are fitted in the pump-room amidships for discharging the oil cargo. They are capable of pumping out the entire cargo of over 4900 tons of oil in 12 hours, and will also pump water from the sea to fill the oil tanks when required for ballast. The vessel will be fitted with a very powerful set of triple-expansion engines, manufactured by the Central Marine Engine Works of Messrs. Wm. Gray and Co. Limited. The cylinders will be 26in., 42in., and 70in. in diameter respectively, and of 45in. stroke. An extra large amount of boiler power also is provided in the shape of three large single-ended boilers, working at a pressure of 160lb. per square inch.

Invisible Torpedo Boats.

At Brest, during the last few weeks, some experiments have been made with an invention, patented by M. Oriolle, of Nantes, for rendering torpedo boats invisible while attacking. The object is sought to be attained by veiling the boats behind a screen of artificially-created smoke. Upon this important subject M. Augustin Normand, the eminent torpedo-boat builder of Havre, writes as follows in "Le Yacht":—

"At the request of M. Oriolle, experiments have recently been made at Brest in the employment of smoke as a concealment from the enemy of the movements of torpedo boats. I beg for space in your excellent journal that I may say a few words as to the consequences which may follow upon the discovery of a sure means of producing smoke or fog of sufficient stability and permanency. Allow me, however, first to recall the fact that eight years ago ('Etude sur les Torpilleurs,' p. 22) I wrote, 'If we could succeed in producing in a practical manner an artificial cloud, such as results from the use of existing heavy artillery, and as was particularly noticeable at the bombardment of Alexandria, we should enormously increase the value of torpedo boats possessed of speed great enough to permit of them placing themselves to windward of a squadron.' At that time my idea provoked smiles. Yet it has made progress. In 1890 an English officer undertook certain experiments, which, however, were but moderately successful. A similar fate awaited some experiments of my own at Havre; the smoke was not sufficiently permanent. As to whether the practical difficulties have been completely overcome at Brest I am ignorant; but it is probable that, if they have not already been overcome, they will be overcome in the near future, and it is not now too early to consider the effects upon the tactics of to-morrow of the discovery. Their importance cannot easily be exaggerated. According to an opinion which is pretty general, daylight attacks upon large ships by torpedo boats alone offer no chances of success. The situation will be very different when we succeed in making our torpedo boats invisible, for invisibility, which is the sole quality in which a submarine boat may be expected to show superiority over an ordinary boat, is so great a desideratum that, in spite of the various difficulties in the way of the employment of submarine vessels, all the navies of the world have devoted attention to them. It is impossible to deny that daylight attacks by torpedo boats which in ordinary weather shall be capable of concealing their movements from the enemy, will have good chances of success. For night attacks the value of the boats is already admitted, but it will be largely increased. Inaccessible to the rays of the search-light, they will be able to see without being seen. Let it be noted, too, that this useful invention, if it be perfected, will not be utilisable by the torpedo boats accompanying a squadron. This fact will reduce the importance of their work, and will materially add to the difficulties of the defence. One probable consequence of the discovery will be the creation of a new type of torpedo boats. Without surrendering high speed, which in certain special cases will always be valuable, we must endeavour to give to the greater number of our seagoing torpedo boats not only larger dimensions, but also the endurance, the strength, the navigability, and the radius of action of a battle cruiser. Habitability and preservation of speed in heavy weather will always be points in which torpedo boats will betray inferiority; but these we must try to improve. Even if we reduce the stipulated speed to 20 knots the sacrifice will not be too great, so long as it enables the boats to get at their enemy, no matter at what distance he may be."

M. Normand wrote on March 20. News, later than he can have then received, is to the effect that the experiments which were carried out by the "Laborieux" and the torpedo boats of the *défense mobile* gave most encouraging results. Further experiments are to be made.

Notices of New Books.

Modern Locomotive Construction. By J. G. A. Meyer. New York: John Wiley and Sons; London: Gay and Bird.

The want of a reliable modern work on locomotive construction, which has been often referred to in these pages, is now and again rendered the more conspicuous by the publication of some excellent treatise by American writers. We have reason to believe that an English work on modern locomotive construction is now in preparation, so that it is probable an attempt to fill this great gap in our engineering literature will be made in the near future. In the meantime, however, we have to turn to American works for good literature on the subject, and although in many respects there is great diversity in the practice of the builders in the two countries, there is still so much common to both as to render any reliable American treatise on the subject of the greatest value to locomotive engineers in this country. This is especially true of the work under notice, which is to some extent a reprint of an excellent series of articles on the subject contributed by Mr. Meyer to the "American Machinist," and which were commenced while the author was engaged as chief draughtsman at the Grant Locomotive Works, then located at Paterson, N.J., and completed after he had joined the editorial staff of our excellent American contemporary. For the present purpose Mr. Meyer has thoroughly revised the papers, and also added about 50 per cent. of new matter, with accompanying illustrations. The following extract from the preface will serve to indicate to some extent the aim of the author:—"In these pages the locomotive is described in detail, and an endeavour has been made to show clearly the application of theoretical principles to the design of the different parts which make up the whole. The aim is to assist practical men whose daily and exacting duties have prevented them from taking up theoretical investigations, and to assist those who are about to enter the business of locomotive building, who have had no opportunity for an extended preparation, to design with confidence and success." Mr. Meyer has specially endeavoured to present rules and formulæ in as simple a manner as possible, and, indeed, he has contrived to treat the subject throughout in an exceedingly plain and straightforward style. In the earlier chapters this is especially noticeable, the explanation of the slide valve being the best we know of both as regards perspicuity and comprehensiveness. We need not detail the heading of the chapters of this work. Suffice it to say that nothing that calls for treatment is omitted, and that nothing is treated in a slip-shod manner. Thoroughness, indeed, characterises the work throughout, no detail being considered too insignificant to receive the careful attention of the author. The illustrations are numerous and excellent, and in themselves constitute a valuable collection of drawings such as are not to be obtained elsewhere. In short, as a practical treatise on the design and construction of the locomotive, Mr. Meyer's work is in our opinion the most serviceable in the English language. Our only regret is that we in this country have nothing to compare with it. The publishers have, as usual, done their work well, and both they and the author are to be heartily congratulated upon the production of so excellent a work.

Elementary Lessons on Steam Machinery and the Marine Steam Engine. By J. Langmaid and H. Gaisford. Torquay: The Fleet Printing Works.

These "lessons" were compiled in 1887 for the use of the naval cadets of H.M.S. "Britannia," by Mr. J. Langmaid. In printing them, however, a large number of sketches have been included, these being furnished by the present instructor in this subject, Mr. H. Gaisford. The course of instruction is divided into four terms, the first of which deals with measurements, materials used in machinery and ship construction, riveted joints, screw threads, shafts, bearings, conversion of motion, etc. In the second term such subjects as packing and stuffing boxes, valves and gearing, friction, and pumps are treated on; while in the third section, boilers, combustion, evaporation, boiler fittings, etc., are considered. The concluding section contains a brief description of a direct-acting marine engine, and in addition treats also on condensers, screw propellers, compound and triple-expansion engines, etc. A short description of the construction of a battleship is appended. The book is very fully illustrated by a number of capital sketches, while the information is especially suitable for intending marine engineers.

Differential Calculus for Beginners. By Joseph Edwards. London: Macmillan and Co.

One or two little books have been published during recent years which may be described as "calculus-made-easy" treatises, these being, as a rule, specially adapted to the requirements of the mechanical engineer. But while they may serve to arouse interest in the subject, it must be admitted that they do very little else. As with all branches of learning, there is no royal road to the calculus, and unless the student has a fair acquaintance with algebra, trigonometry, and conic sections, he will find his progress beset with difficulties. But given this requisite preliminary knowledge, Mr. Edwards' little treatise will serve admirably as an introduction to the larger works on the subject. The definitions given are clear and concise, and the large number of excellent examples interspersed throughout the text will unquestionably greatly assist to elucidate it. We have pleasure in commending this little work as an excellent rudimentary manual on the subject.

The Mechanics of Architecture: A Treatise on Applied Mechanics especially adapted to the Use of Architects. By E. Wyndham Tarn. London: Crosby Lockwood and Son.

Mr. Wyndham Tarn is the well-known author of several works on building and architecture, and his object in preparing the present treatise is to bring together all that is essential for the architect to know upon the subject of mechanics, and to give in a simple form an outline of the principles which underlie good construction. The work contains little that cannot be found in the standard works of recognised authorities, but the work will, we believe, be found of especial service to architects and builders, as it contains the essence of the larger treatises on mechanics so far as relates to this branch of industrial art.

We have also received:—"Electrical Tables and Memoranda," by Silvanus P. Thompson and Eustace Smith (E. and F. N. Spon; 1s.). This little waistcoat-pocket book contains many useful data on electric lighting, wiring, jointing, testing, Phœnix Fire Office rules, notes on magnetism, arc lamps, accumulators, lightning rods, tables, etc. Altogether this forms a very useful companion for the electrical engineer, and it is very cheap.—"A Pocket Glossary of Technical Terms: English-French and French-English; with Tables, etc.," by J. J. Fletcher (Crosby Lockwood and Son; 1s. 6d.). This is the second edition of a book also suitable for the waistcoat pocket, and containing the principal technical terms likely to be required in English and French. Several useful tables for engineers are appended, these alone being of considerable value.—With the April issue, "Science and Art" is enlarged, and the price increased to 6d. monthly. The subjects treated on include Spectrum Analysis, Our Technical Schools, Science and Art Biographies (containing a sketch of the career of Lord Kelvin), Art Drawing and Education, etc. The first issue of the new series is a great improvement in every way, and the publishers, Messrs. Chapman and Hall, are to be congratulated upon the spirited manner in which they are catering for science and art teachers.—The second edition of "Elementary Engineering," by J. S. Brewer (Crosby Lockwood and Son) contains a new chapter on Recent Developments. The work will be found of service by apprentices and young marine engineers, but we do not approve of the "catechism" method of presenting facts.—"Work," for April (Cassell and Co. Limited; 6d. monthly), contains useful papers on a variety of subjects, including Watch and Clock Making and Repairing, Chemical Apparatus, Stained Glasswork, The Spectroscope, papers on Plumbing, etc.—Mr. Wallace Bentley, of Halifax, has recently published a small pamphlet, "Rules and Definitions for Students in Engineering Subjects" (price 6d.). The definitions appear to be accurate and concise, while they are also well arranged.

We have also to acknowledge the receipt of the second volume of the Record of Transactions of the Junior Engineering Society. The papers deal with the Electrometallurgy of Copper; Engineering Practice in the Cleveland and North-east Coast Districts; The Gas Engine; Presidential Address by Sir E. J. Reed; Direct-acting Steam Pump; Shipbuilding at Blackwall and District; and Suspension Bridges. There are also several accounts of visits of the members to various works, etc. The volume bears signs of having been carefully edited, and in every way compares most favourably with the (often much more prosaic) proceedings of the older institutions.—We have also received a copy of the Annual Report of the South Australian School of Mines and Industries. This includes the examination papers set in 1892, of which those in Mechanical Engineering, Mechanics, and Machine Construction are worthy of the attention of some of our Science and Art Department examiners. We may say, in passing, that included in the donations to the library is quite a long list of illustrated catalogues received from leading American manufacturing firms. We do not, however, find the names of any English firms mentioned. We hope this does not imply that our manufacturers do not yet understand the advantages to be derived from sending copies of illustrated catalogues to our technical schools and colleges in the colonies.

Trade Notes.

The Gloucester Carriage and Wagon Company have acquired the business of Messrs. Mousell Brothers, Gloucester.

The works of the Renfrew Forge and Steel Company Limited have been closed down, all the men having been discharged.

The Cockerill Company, of Liege, Belgium, have secured an order for about 4000 tons of material for the Baden State Railways.

Messrs. Lloyd and Lloyd, of Birmingham, have received an order for a quantity of iron tubes from the Italian naval authorities.

Messrs. Somervail and Co., of Dalmuir, have secured the contract for the building of the bridges of the Forfar and Brechin Railway.

The Leeds Steelworks, Hunslet, have contracted to supply 4000 tons of steel which is required for the extension pier at Karachi Harbour.

A contract for 1033 tons of water pipes for the Glasgow Water Commissioners has been placed with Messrs. Cochrane, Grove and Co., Middlesbrough.

Messrs. Sharp, Stewart and Co. Limited, Atlas Works, Glasgow, have obtained an order for five small locomotives for the Tradeston and Dalmarnock Gasworks.

The Union Ironworks of San Francisco have contracted to supply a large plant of modern pumping machinery to the San Rafeal Mining Company of Pachuca.

Messrs. T. Olson and Co., of Philadelphia, are supplying a 100,000lb. autographic testing machine to Messrs. Wm. Cramp and Son, shipbuilders and engineers

The contract for the equipment of the sub-stations for the Electric Lighting Committee of the Bristol Corporation has been secured by the Brush Electrical Engineering Corporation, Lambeth.

The Luhrig Coal and Ore Dressing Appliances Company, London, are manufacturing for the Transvaal Silver Mines Company a complete ore-dressing plant, to treat 100 tons of silver lead ore per day of 10 hours

Messrs. R. and J. Dempster, of Newton Heath, Manchester, have just completed the erection, at Burslem, of the largest gasholder ever made, on the Gadd and Mason principle. It is 90ft. in diameter, and when inflated is 60ft. in height, and has a capacity of about 350,000 cub. ft.

Messrs. Merryweather and Sons, Greenwich-road, London, have just supplied to the Liverpool Corporation a steam fire engine, which is said to be the largest of the kind arranged for hose traction in the world. It discharges 1400 to 1600 gallons of water per minute, and weighs only about four tons.

Messrs. E. Green and Son Limited, of Manchester and Wakefield, have just secured the contracts for fuel economisers to heat the feed water in connection with the steam boilers to be erected at the stations of the Londonderry and Nottingham electric light installations, and also at the installation about to be put down by the Great Northern Railway Company, at Holloway station, London.

We understand that the business of Messrs. Pickering and Co., hoisting machinery engineers, 5, John Dalton-street, Manchester, which was amalgamated last year with two other engineering firms, has been withdrawn from the same and transferred to more advantageous premises. It has been combined with the firm of Messrs. J. Swain and Co., hot-water engineers, Hyde, and in future will be known as Messrs. Pickering, Swain and Co. Limited, with registered offices at 5, John Dalton-street, Manchester, where all the commercial work will be carried on. The new firm will continue to occupy Russell-street Ironworks, Hyde.

Having regard to the enormous circulation of The Mechanical World, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if Mechanical World readers will kindly bear this in mind as occasion arises.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 85, Strand, London, or New Bridge-street, Manchester.

1500I.H.P. Triple-expansion Mill Engines.

HEREWITH we have pleasure in illustrating a very fine pair of engines constructed by Messrs. Daniel Adamson and Co., Dukinfield, for the Minerva Cotton Spinning Company Limited, Ashton-under-Lyne. As will be seen from Fig. 1, the general arrangement is that now very low-pressure 40in., the stroke being 6ft. The engines have been designed for a boiler pressure of 160lb. per square inch, under which pressure, and running at 55 revolutions per minute, they will easily develop 1500I.H.P. The power is transmitted by ropes, the rope drum being 30ft. in diameter, grooved for 40 ropes 1½in. diameter, the speed of the ropes being 5185ft. per minute. The drum is built up The framing of the engine is of the well-known trunk-girder type, and is of very substantial proportions throughout. The portions of the frame nearest the cylinders have the slides for the crossheads cast therein, and these are bored out at the same time as the flanges are faced for jointing to the cylinders. At the end of each slide a substantial foot is cast, by which the frames are secured to the foun- flanges faced for jointing to the cylinders at one operation, the whole engine being thus jointed together with faced joints from the machine in true alignment with each other. The distance pieces are also made of such an internal diameter as to allow of the cylinder covers being removed and pistons examined without disconnecting any other parts of the engine. Another important advantage claimed by the makers

1500 I.H.P. TRIPLE-EXPANSION MILL ENGINES

MESSRS. DANIEL ADAMSON AND CO., ENGINEERS, DUKINFIELD.

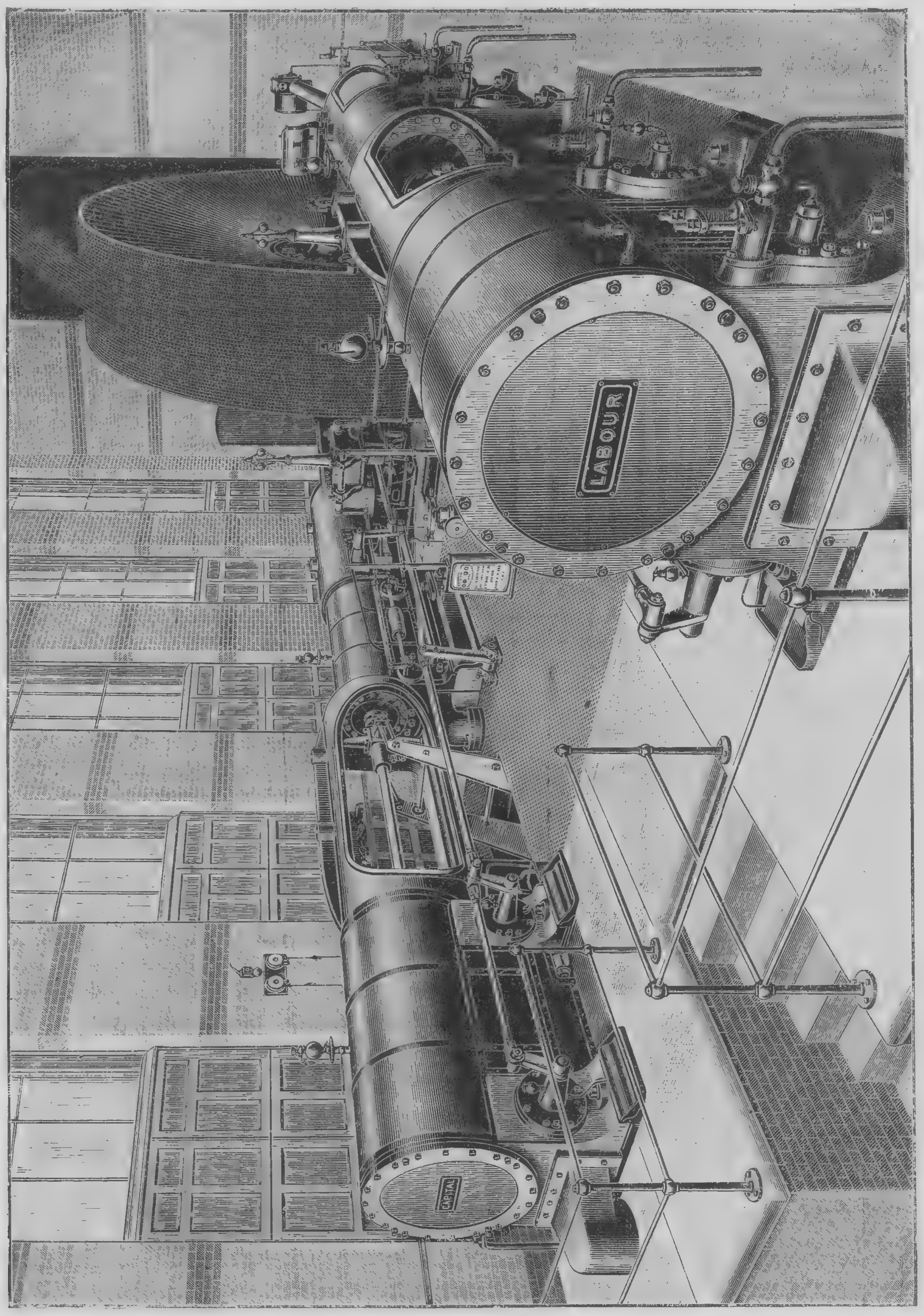


FIG. 1.

generally adopted for horizontal triple-expansion mill engines, two low-pressure cylinders being employed on each side and forming a pair of tandem engines, driving on to cranks at right angles. We have on previous occasions adverted to the advantages of this arrangement for high-class mill engines, perfectly steady running and an equal distribution of the load on each crankpin being not the least advantages obtained.

The high-pressure cylinder is 22in. in the bore, the intermediate 36in., and each

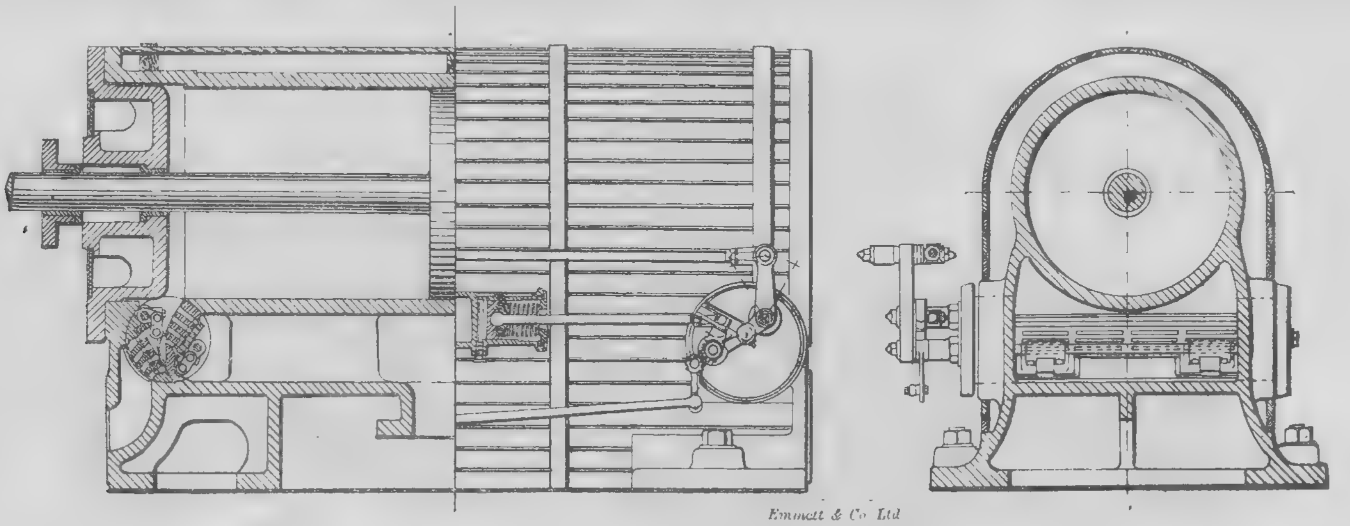
in segments, with loose arms and boss, having only one set of arms and rim segments and one boss. The arms are socketed into the boss and bolted to the rim segments, all joints throughout being truly machined. The drum is also cased in with polished pine, and has an internal barring rack cast within the brim. One of the makers' improved type of automatic safety barring engines, for moving or starting the engines for any purpose, is provided. The finished weight of the rope drum is 65 tons.

dations, whilst at the ends of the frames nearest the crankshaft a suitable flange is provided for jointing the frames to the crankshaft pedestals, these being cast separate and bolted to the frames. Between the two tandem cylinders on each side are fitted cast-iron distance pieces, having slides cast therein in a similar manner to the main frames, for a crosshead, which is utilised as a coupling for the piston rods of each pair of cylinders, and also forms a support for the rods. The distance pieces are bored out for the crossheads and the

is that there are no steam joints which cannot be made good with the minimum of trouble, as all these are perfectly accessible, and do not in any way necessitate a disturbance of the structural parts of the engine. It will also be noted that the coupling crosshead is used for driving the air pumps, which are fixed immediately underneath the distance pieces, and are of the usual single-acting bucket type, driven direct from crosshead by steel plate levers. The two low-pressure cylinders are fixed upon separate cast-iron foundation frames,

which are bolted securely to the foundations, provision being left for the low-pressure cylinders to slide freely thereon, and thus to accommodate themselves to the expansion and contraction of the engines when hot and cold.

The crankshaft pedestals are fitted with phosphor-bronze steps, made in four parts, the two side sections being adjustable horizontally by means of wedges and screws fitted through the pedestal caps, whilst the top and bottom sections are turned and fitted into bored seats prepared for them, allowing their removal for examination or renewal with very little trouble and a very slight lifting of the shaft.

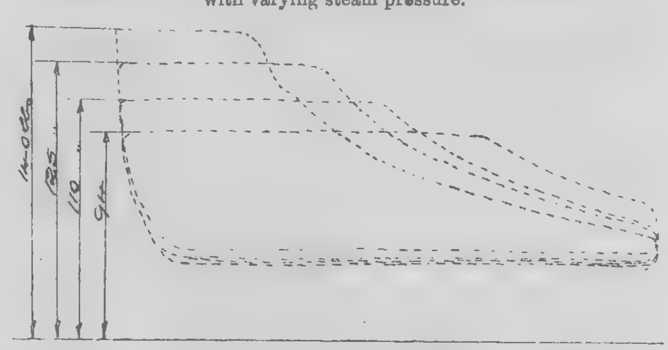


TRIPLE-EXPANSION ENGINES.—FIG. 2.

The high and intermediate-pressure cylinders are each fitted with automatic expansion gear, each being controlled by a separate and independent governor positively driven by gearing. The two low-pressure cylinders are fitted with circular semi-rotating valves, one at each end of the cylinders, and of the makers' latest type. The expansion gear is of the Wheelock type, of which Messrs. Daniel Adamson and Co. are the sole makers in Great Britain, they having made it one of their specialities since the year 1878, when it was brought prominently into notice in this country owing to its being exhibited and obtaining the highest awards at the Paris Exhibition of that year, since which time it has been shown at most of the principal exhibitions with similarly successful results.

In Fig. 2 is shown the general arrangement of the valve gear, which is of the latest Wheelock type. A single eccentric is employed, this driving both the steam and exhaust valves, and allowing automatic control of the expansion from 0 to 75 per cent. of the stroke, while complete control of the periods of release and compression is retained. From the sections shown in Fig. 2, it will be seen that the valves are of the flat-grid type. These are driven by levers having a vibrating motion, and keyed on the valve spindles, as in the earlier type of Wheelock valve, and are connected to the eccentric by means of adjustable coupling rods in the usual manner. The steam valves are driven from the exhaust valve levers by means of the well-known Wheelock latch link, and are tripped by cams, the valves being instantly closed by means of a helical coil spring working in an air-compression cylinder, cushioned and noiseless in action. These cams receive a positive travel from the eccentric rod, the timing of the travel being under the control of the governor. The resultant action obtained is capable of tripping the latch link in every position of the gear, and when moving in both forward and backward directions. There are also provided, in suitable positions, safety cams, which prevent the steam valves opening in case of accident to the governor. The valves and seats are of the flat-grid type, giving a number of openings and small frictional surfaces. By the combination of a toggle-joint connection from the spindles, an almost instantaneous opening and closing of the valves is secured, with great ease of action under extreme pressures. One chest at each end of the cylinder contains both steam and exhaust valves, the seats being formed in a plug turned to fit the cylinder, and made of specially hard and durable iron, enabling spare valves to be kept in stock, while entirely obviating wear in the cylinder casting. The valve spindles are of the Wheelock patent self-packing type, which dispense entirely with the usual stuffing-boxes and glands, and are also practically frictionless.

Diagram showing action of Governor and range of Cut-off Gear with varying steam pressure.

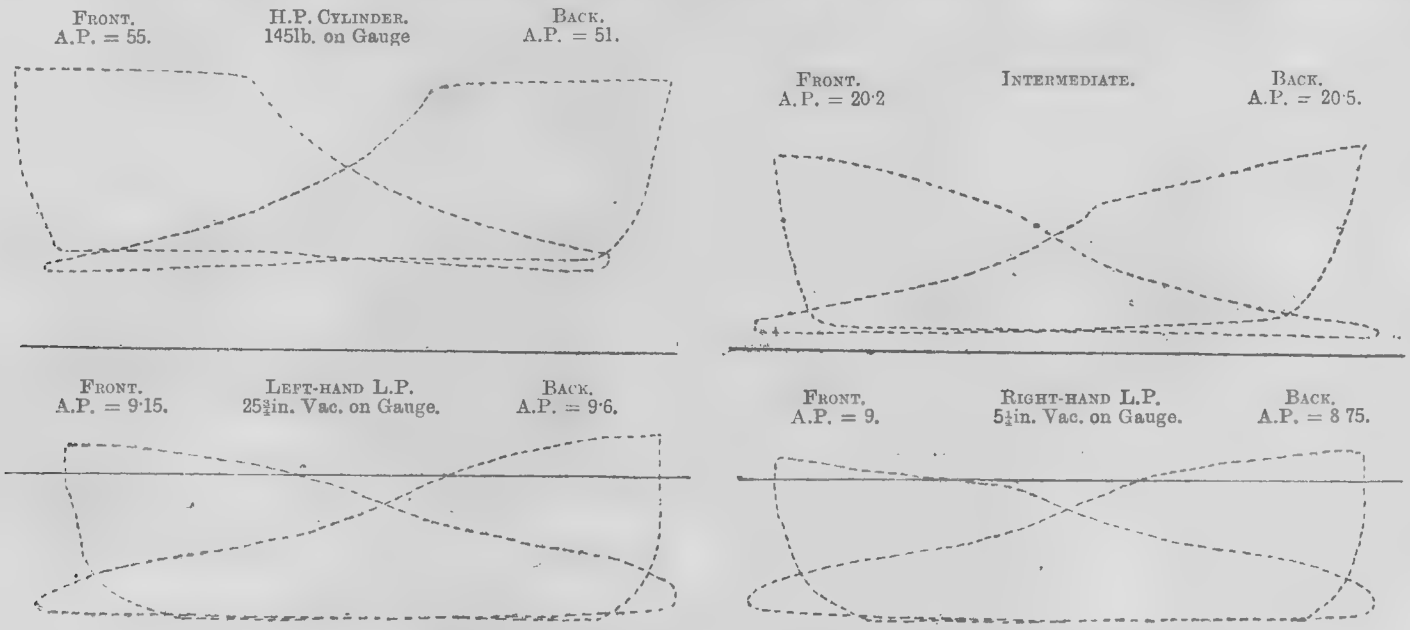


TRIPLE-EXPANSION ENGINES.—FIG. 4.

The piston rods are of forged mild steel, and their stuffing-boxes are fitted with metallic packing throughout. The crank-shaft is of Siemens-Martin mild steel, the journals being two diameters long. These are fitted with oil-circulating pumps to return all the oil used from a low-level receiving cistern to a cistern fitted upon the pedestal caps, from which the supply of oil is regulated by means of a series of taps. The oil for lubrication is thus used over and over again, being strained thoroughly at each change. This system of oiling gives very good results and keeps the bearings in perfect condition with very little expenditure of lubricant. Independent governors are employed to control the high and intermediate-pressure cylinders, the high-pressure gear being also fitted with a Higginson's regulator, previously described in these pages. The main stop valve is also fitted with Tate's patent electric stop motion, arranged to close the valve automatically in case of accident in the mill, to the different rooms of which it is connected.

The engines, which we have recently had the pleasure of inspecting, are more than usually complete. The cylinders and pipes are clothed with non-conducting composition, and the bodies of the cylinders finished off with planished steel sheets bound with brass belts. They are also provided with a complete set of automatic and hand lubricators, indicator and drain taps, indicator gear, steam and vacuum gauges, and a complete set of oil catchers and drippers, wherever required, and also hand rails and guards round dangerous places.

The engines, which have been running since September last, have given the greatest satisfaction from the first start. They are not yet fully loaded, as the whole of the machinery has not yet been got to work. We give, however, a set of indicator diagrams, which, notwithstanding the disadvantages of running under power and with a reduced boiler pressure, sufficiently indicate the capabilities of the engine and valve gear under notice. From the appended data it will be noticed how remarkably equal are the amounts of power developed by each engine, while from the supplementary diagram (Fig. 4) the action of the governor in controlling the cut-off under varying steam pressures and with a constant load is very clearly seen. We may add that the Mosscrop recorder diagrams show great regularity of running, and that in general design, workmanship, and finish these engines leave nothing to be desired.



145lb. on gauge; 56 revs. per minute; all 6ft. stroke; mean vac., 25½in.

H.P. cylinder	22in. dia.	Mean pressure = 53	I.H.P. = 410·1
Intermediate cylinder	36in. dia.	Do. = 20·35	I.H.P. = 421·4
Left-hand L.P. cylinder	40in. dia.	Do. = 9·375	I.H.P. = 239·8
Right-hand L.P. cylinder	40in. dia.	Do. = 8·875	I.H.P. = 227

Total I.H.P. = 1298·3

H.P. cylinder + left-hand L.P. cylinder = 410·1 + 239·7 = 649·8 on left-hand crank.

Intermediate cylinder + right-hand L.P. cylinder = 421·4 + 227 = 648·4 on right-hand crank.

TRIPLE-EXPANSION ENGINES.—FIG. 3.

The Sizing of Marine Engines.

A MEETING of the Institute of Marine Engineers was held on April 10 at the Institute premises, 58, Romford-road, Stratford, when Professor A. C. Elliott, D.Sc., president of the Bristol Channel Centre, read a paper on "The Sizing of Marine Engines." Mr. J. A. Rowe presided.

Professor Elliott, in opening, said: The business of the marine engine is to turn a shaft. It is obvious that the shaft will do the most work for its strength, and the best work in propulsion, when the motion is uniform, and the effort and resistance consequently also uniform. It being granted that no other economical conditions are violated, it follows that that engine will be of its type the best designed in which the combined crank effort shows the smallest variation; whence appears the mechanical advantage of the compound over the simple, the (three-crank) triple over the ordinary compound, and the (four-crank) quadruple over the triple—all with with same expansion. To secure as far as possible with a given engine this desirable condition of uniform torque, it is customary to arrange the valve gear so that in ordinary running trim the engines are balanced—*i.e.*, equal indicated powers are developed in each cylinder; and similarly in designing an engine the condition of power balance is usually taken as part of the data. Now this is equivalent to balancing the mean piston forces—taking for granted the invariable practical condition of equal strokes; and it is very often assumed that with a given engine or type of engine this arrangement corresponds exactly with minimum variation of torque between its maximum and mean values. But when it is considered that for a particular crank maximum torque occurs in general on the first half of the down stroke, whether cut-off be very early or very late, one sees at once that the pure torque variation in question is much more closely related to initial piston force than to mean piston force. For some considerable time the author has replaced in his own practice the condition of balanced horse-powers by that of balanced initial piston forces. The result has been highly satisfactory.

Dr. Elliott illustrated his paper by a free use of the blackboard, on which he reproduced numerous tables and formulæ relating to construction of marine engines of various types. He also made several references to a paper on this subject, read at a previous meeting of the institute by the late Mr. M'Millan.

The Chairman, in opening the discussion on the paper, said he had no doubt that a great many of the facts which Dr. Elliott had placed before the meeting in algebraical form were familiar to most of them, but the careful manner in which he had brought the subject to their notice would no doubt help them to design engines more perfectly than hitherto; and, assuming that the conclusions which the author had arrived at were correct, they would go a long way to assist those who required to design engines to obtain certain results. With regard to the novelty of the view that the diameter of the intermediate cylinder in triple-expansion engines should be the geometrical mean of the diameters of the high and low-pressure cylinders, he (the chairman) thought that that idea had been anticipated for some years. He remembered listening to a paper read in the North of England by Mr. A. Taylor, who used to be credited with having brought the triple engine into use, and during the discussion on that paper Mr. Crawford, who was then the manager to Mr. J. Dickenson, of Sunderland, dealt with the relative proportions of the three cylinders, and he laid it down that the diameter of the intermediate should be the geometrical mean of the diameters of the other two. He (the chairman) had also referred to his notes of the dimensions of engines with which he had personally to deal, and having looked at about a dozen cases, he found that they nearly all conformed to this rule.

Mr. R. Bruce said there could be no doubt that the very able and instructive paper which had been brought before them by Dr. Elliott would require careful study before they would be in a position to discuss it. They were not daily acquainted with such problems as Dr. Elliott had introduced to their notice; but he (Mr. Bruce) agreed with the chairman that on closer study those members who were engaged in the proportioning of marine engines would find this contribution to their literature of considerable value. The learned lecturer had touched on one phase of marine engineering which seemed at the present moment to have reappeared from the obscurity in which it has been hidden for some time past. He referred to the question of what were called high-pressure compound engines, and Dr. Elliott seemed to be under the impression that this type of engine was of recent date; but this was not the case. High-pressure compounds had been in vogue for many years, and the utility of this style of engine could not be denied from certain aspects. Mr. Evans, of Liverpool, had been building this type of engines for a number of years, but the question was one of ultimate coal endurance with economy in maintenance, and so far as experience indicated, in cases where first cost was not the predominating consideration, the conversion of a marine engine to triple-expansion, with Howden's system of forced draught, was certainly the most advantageous course to pursue in cases where the propelling machinery has to be reconstructed. By these means not only was the coal account brought down, but the cargo spaces were much increased, and steamers which had been obsolete were now running in regular service. On the other hand, in some instances shipowners had not altered their engines, and had simply renewed their boilers, working the new ones under Mr. Howden's system, at the original pressures for which the engines were intended, with excellent results, and in such cases the item of first cost had been a minimum, with a maximum of gain all round. On the general question of economy of high-pressure compounds as compared with triples, a most interesting account of an experiment was placed before the Institute of Naval Architects at their recent meeting by Mr. John Inglis, of Glasgow, who made some trials with a set of triple-expansion engines. They eliminated practically the intermediate cylinder, and tried the other two with the same pressure, the engine running as a compound, when the difference in favour of the triple type was found to be some 30 per cent. If that result obtained generally in practice, high-pressure compounds would not find favour with shipowners. It had also been said that to use these high-pressure compounds with an early cut-off involved the use of an expansion valve; but he knew of engines that were running up to 160 without any expansion gear at all, so that if high-pressure compounds really came into use in the mercantile marine, there was no necessity to complicate the gear by adding expansion valves.

Mr. M'Farlane-Gray said that Dr. Elliott had treated this interesting subject in a masterly manner, presenting his deductions in mathematical form just as if he were addressing his own students in University College, Cardiff. The relation of successive areas deducted by the author, when there was no drop, was perhaps more simply expressed as that the successive cylinders increased in the same ratio. If this held for areas it must also hold for diameters, and in triples they found that the successive diameters were about as six to ten. The rectilineal subdivision of the hyperbolic diagrams into equal work areas gave the abscissæ of volume in geometrical ratio. This followed because the work area was proportionate to the hyp. log. of the ratio of expansion; therefore equal work areas meant equal volume ratios. Dr. Elliott had gone beyond this primary elementary view, and had worked out how these ratios were modified by the actual drop there was for any receiver. The work involved in such investigations was very great, and they ought to appreciate highly what the author had done, and his kindness in coming from Cardiff to read the paper to them. At the Institution of Civil Engineers on the following evening the best proportions for cylinders and the best ratios of expansion were to be dealt with from the experimental side in the paper left by the late Mr. Willans. If Dr. Elliott would take the numerical results arrived at by Mr. Willans, and arrange them into formulæ, he would be testing his theoretical deductions and making the results of experiment more manageable in application. Only a mathematician like the author of the present paper could arrange these into formulæ. It was only by such a comparison of theory with practice that the value of the present paper could be measured.

After some further discussion,

Professor Elliott briefly replied, and said he regretted that the paper was not so complete as he could wish, but since he undertook to have it ready for this meeting he had had a serious illness. Referring to the conversion of the old compound engines of the "Mark Lane" into high-pressure engines, he claimed the credit for what was done in that case for Mr. Ferrier, a member of the institute. He knew that the alteration carried out on that steamer was originally projected by Mr. Ferrier.

The discussion on the paper was adjourned until Monday, April 24.

Mr. J. Adamson (honorary secretary) proposed a hearty vote of thanks to Dr. Elliott for his paper and for his attendance, he having come up from Cardiff in order to attend the present meeting. There had been a great deal of discussion on this question of high-pressure compounds in the engineering press of late, and they awaited with much interest the results of the conversion that was carried out in the case of the "Mark Lane."

Mr. Shorey seconded the motion, which was carried unanimously, and a vote of thanks to the chairman concluded the proceedings.

Institution of Mechanical Engineers.

THE ensuing ordinary general meeting of this institution will be held on Thursday evening, 20th, and Friday evening, 21st April, at 25, Great George-street, Westminster. The chair will be taken at half-past seven p.m. on each evening, by the president, Dr. William Anderson, F.R.S. The following papers will be read and discussed, as far as time permits:—"Second Report to the Alloys Research Committee," by Professor W. C. Roberts-Austen, C.B., F.R.S.: Possibility that mechanical properties of a metal will be influenced by small quantities of added elements in proportion to their atomic volumes: thermal capacity, elasticity, rigidity, cohesion; molecular porosity in relation to atomic volumes; influence of impurities on copper; tensile tests of copper rods; mode of casting pure electrolytic copper in thin rods, free from oxidation; working of experimental copper rods; hydraulic single-lever testing machine; appliance for determining limit of elasticity; effects of arsenic, of bismuth, and of antimony on copper; curves showing influence on tenacity of copper; series of copper-bismuth alloys; autographic curves of cooling; higher and lower points of solidification in cooling; effect of pressure on recalescence of steel; Newton's metal, triple alloy of bismuth-lead-tin; cooling under pressure; thermal behaviour of chromium steels: their melting points; improved autographic recording pyrometer; general conclusions. "Tensile Tests and Chemical Analyses of Copper Plates from Fireboxes of Locomotives on the Great Western Railway," by Mr. William Dean, Locomotive Superintendent: Tabulated details of copper firebox plates; mileages; tensile tests: breaking stress, contraction of area, elongation; testing machine, and test pieces; chemical analyses. "Research Committee on Marine Engine Trials: Abstract of Results of Experiments on Six Steamers, and Conclusions drawn therefrom in regard to the Efficiency of Marine Boilers and Engines," by Professor T. Hudson Beare, F.R.S.E., of London: Steamers tried; their dimensions and speed on trial; general description of boilers; observations made, and relations between them; fuel: analysis and thermal values of ash losses; feed-water in relation to boiler and to fuel; priming; funnel gases: quantities of air used; radiation losses; general conclusions as to points which affect efficiency of marine boilers of kinds experimented upon; general description of engines; observations made; power measurements, and pressures in receivers and condensers; back-pressure losses in low-pressure cylinder; wire-drawing of steam between boiler and high-pressure cylinder; feed-water in relation to engine and power; steam-jackets, their influence on initial condensation and on re-evaporation; steam accounted for by indicator diagrams; general conclusions as to points which affect efficiency of marine engines.

Shipbuilding on the Clyde.

IN a report just issued it is stated that the production in shipping for March shows a large falling off when contrasted with the corresponding months of 1892 and 1891. Altogether, 28 vessels, measuring 26,638 tons, were placed in the water; as against 86 vessels, aggregating 48,173 tons, last March, and 31 vessels, with a total of 40,113 tons, in the corresponding month of 1891. The work in hand this month has been augmented to the extent of 118,000 tons, which bears a favourable comparison to the new contracts booked during March, 1892, but as the tonnage launched exceeds the new work by 8638 tons, the shipbuilding market is quiet. The work under contract at present is estimated at 209,000 tons, compared with 240,000 at the same time last year, and 274,000 on 31st March, 1891. Most of the new work is being built in the upper reaches of the Clyde. Twelve months ago the position was reversed, for then the great bulk of the tonnage was in the hands of the builders at Greenock and Port-Glasgow. At few other periods in the history of marine craftsmen on the Clyde as of late have so many splendid vessels been launched from the yards. In illustration of this, it is only necessary to point to the examples congregated at the Tail of the Bank during the last few days. What modern steamships connected with either the navy or the mercantile marine could surpass the battleship "Ramillies," the first-class cruiser "Gibraltar," the Cunard liner "Campania," or the channel paddle steamer "Leopold II."? They are the productions of four of our leading shipbuilders, and may fairly be claimed as types of the best work that could be turned out in any part of the world. All the signs of the time point that finality cannot be associated with the building of ships, and though formidable rivals may have to be counted with from other parts, yet we feel sure that Scotch shipbuilders can hold their own, and will be able to bring back better times.

Metal Trade Memoranda.

The output of ore from the Marbella Iron Ore Company's mines during the month of March was 1192 tons.

The total output of gold in Witwatersrand district (South Africa) last month amounted to 111,474oz., against 93,252oz. in February last and 93,244oz. in March, 1892.

The shipments of iron and steel last month reached a total of 220,837 tons, as compared with 218,980 tons in March, 1892, and 256,439 tons during the third month of 1891.

The sale is announced of the Corngreaves Iron and Steel Works of the New British Iron Company, situated in South Staffordshire. It is one of the largest concerns in that district.

The African Gold Recovery Company have recovered 20,000oz. of gold at the Rand by means of the Macarthur-Forrest process during the month of March, being 18 per cent. of the total month's production of 111,474oz.

It is proposed to form a combination of the leading iron pipe manufacturers in the United States, to be known as the New American Pipe and Iron Company. It will comprise ten of the largest iron and steel foundries in the South and West.

The copper statistics for the past month, issued by Messrs. H. R. Merton and Co., give the stocks in England and France at 55,271 tons, against 57,420 tons at the end of February. Deliveries have not been quite so much, but supplies have fallen off from 9226 tons in February to 7730 tons in March.

The New England Copper Company, at Central Falls, Rhode Island, U.S.A., have successfully completed a large electrolytic copper refinery for the Boston and Montana Company at Great Falls, Mont. The main building, which covers 300ft. by 525ft., contains 288 depositing vats, which are filled with 1,600,000lb. of pig copper in the shape of anodes. This plant is capable of turning out 1,200,000lb. of pure electrolytic copper per month.

New Companies.

AUTOMATIC AND INSTANTANEOUS BOILER CIRCULATOR COMPANY LIMITED.—This company was registered on the 10th inst., with a capital of £5000, in £5 shares, to purchase patents, etc., and in particular to acquire the benefit of an invention of "Improvements in apparatus for promoting the circulation of water in steam generators." The control of the business is to be placed in the hands of managers. The first managers are to be H. C. Ashlin and J. Dalglish, both of 23, Water-street, Liverpool, consulting engineers; remuneration as fixed by general meeting. Registered by T. T. Hull, 22, Chancery-lane, W.C.

The Metal Market.

PRICES CURRENT.

LONDON, April 17.

COPPER opened slowly, but prices for a time were well maintained, three months making £45, eight days £44 13s. 9d., and cash £44 15s. 6d. Owing to realisations cash shortly afterwards declined to £44 12s. 3d. and three months to £44 18s. 9d., and although £44 11s. 3d. and £44 10s. combined were taken for cash, the market, generally speaking, ruled steady at the higher figure to the close, when values were 1s. 3d. lower on the day. Sales, 700 to 800 tons. Settlement price, £44 10s.; English tough, £48; best selected, £49 to £49 10s.; strong sheets, £56 10s. to £57. Messrs. H. R. Merton and Co. give the Chili charters for the first half of the month at 500 tons. Messrs. James and Shakspeare make the receipts in England and France over the same period 2739 tons, and deliveries 4837 tons, showing a decrease in stocks of 2098 tons, and the total visible supply now is 55,823 tons, against 55,271 tons at the end of last month and 54,307 tons a year ago.

TIN opened with a cash buyer at £94 15s., or 2s. 6d. down, which was subsequently accepted. The market has been without feature, buyers holding off, and this induced a cash sale at £94 10s. towards the close. The only other busi-

ness was an odd lot of Boustead Penang, sold early at £95 7s. 6d., and the market closes quietly at 5s. to 7s. 6d. decline. Sales were inconsiderable. Settlement price, £94 10s. English ingots, £9. The quantities of Straits landed and delivered here during the first fortnight of April have been respectively 474 and 656 tons, and warehouse stocks are now 2749 tons, against 3023 a month ago. The shipments of Straits for the first fortnight were only 810 tons, London taking 590, America 130, and the Continent 90. Amsterdam market quiet, with Billiton at 56 and Banca 56½.

PIG IRON opened with cash bids of 40s. 11d., but sellers missed their market, only 40s. 10½d. being afterwards obtainable. No business was done, and closing rates generally are unchanged to ½d. down. Settlement prices:—Scotch, 40s. 10d.; Middlesbrough, 34s. 4d.; hematite, 45s. 7d.

TINPLATES dull, but unchanged. I. C. cokes, f.o.b., Swansea, 11s. 9d.

LEAD is somewhat weak, and £9 13s. 9d. is the nearest price of Spanish; English, £9 15s. to £9 17s. 6d.

SPELTER has declined 2s. 6d., offerings being made at £17 12s. 6d. for any position.

ZINC SHEETS.—Silesian are quiet, at £20 17s. 6d. to £21, ex ship; Belgian steady and unaltered; V.M. brand, £20 17s. 6d. ex ship, and £20 15s. f.o.b. Antwerp.

OFFICIAL CLOSING QUOTATIONS.

	To-day.
COPPER—	£ s. d. £ s. d.
G. M. B.—Cash	44 11 3—44 18 9
" Three months	44 18 9—45 6 3
TIN—	
Fine foreign—Cash	94 10 0—95 0 0
" " Three months	90 0 0—90 10 0
Australian—Cash	95 2 6—95 12 6
PIG IRON—	s. d.
Scotch warrants—Cash	40 10½
" One month	41 1
Middlesbrough—Cash	34 4
" One month	34 6
Hematite—Cash	45 7
" One month	45 9

GLASGOW, April 17.—The pig iron market has been very quiet. At the forenoon session 2000 tons Scotch sold at 40s. 11d. cash, and at the afternoon meeting 500 tons at 41s. 1½d. one month, and 1000 tons Clevand at 34s. 5d. The market seemed to be supported, but was dull at the finish. The shipments of Scotch for last week were fairly good—8135 tons, being an increase on corresponding week of 1821 tons, thus reducing the decrease on the year to 1115 tons.

QUOTATIONS:—

	Scotch.		Middlesbrough.		Hematite.	
	Cash.	1 m'th.	Cash.	1 m'th.	Cash.	1 m'th.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Highest	40 11	41 1½	34 5	34 6	45 7	45 9
Lowest	40 10	41 1	34 4	34 6	45 7	45 9
Close	40 10½	41 1	34 4	34 6	45 7	45 9
Prev.close	40 11	41 1	34 4½	34 6½	45 7	45 9

Official Gazette.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Receiving Order.

R. CROSTHWAITE, Queen Victoria-street, E.C., and Norwood-road, Tulse-hill, S.E., iron merchant.

Order made on Application for Discharge.

C. WRIGHT, Romford, Essex, toolmaker—unconditional discharge granted.

Letters to the Editor.

*** *We do not hold ourselves responsible for opinions expressed by correspondents.*

*** *The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

*** *Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

RAILWAY SPEED.

To the Editor of THE MECHANICAL WORLD.

SIR,—I notice in your last issue a statement by Mr. Clement Stretton on the above subject, to the effect that he has never succeeded in timing any train above a speed of 80 miles per hour. This, however, is no satisfactory proof that a higher rate of speed has not been reached.

No doubt many of your readers will be aware that the highest authentic speed ever recorded in this country was attained by Mr. Worsdell with one of his large single-compound express engines. In the course of a series of exhaustive and careful experiments with one of these engines, the speed of 86 miles per hour was reached, which is the highest ever recorded officially in this country. These engines, as your readers may be aware, have cylinders 20 and 28in. diameter by 24in. stroke, and boiler pressure of 175lb. per square inch, and no doubt this may account for their unparalleled performance when on their trial in the experiments alluded to.

COMPOUND.

Miscellaneous Items.

The Corporation of Birkenhead have decided to spend £10,000 on electric lighting.

The Electric Tramway which has been in course of construction for some time at Herstal, near Liége, will shortly be set in operation.

The Peninsular and Oriental Company's steamer "Oriental" has arrived at Bombay with the British mails, making the passage in 14 days 2½ hours, which is the shortest time on record.

The British South Africa Company have resolved to construct the Vryburg-Mafeking line itself, the engineers of the company giving out and supervising work, which will begin at once.

On and after May 1 next the running of second-class carriages on the London and North-Western and Caledonian Railways between stations in England and Scotland will be discontinued.

By adding a little tungsten to aluminium, a French metallurgist claims to greatly increase its resistance to corrosion by hot, cold, or salt water and other re-agents, as well as to traction and tension.

The first railway in Siam, connecting Bangkok with the Port of Paknam, at the mouth of the Menam river, was opened for traffic on the 11th inst. by the King. The first sod of the new line was cut in July, 1891.

Four of the new 67-ton guns, which are superseding the 100-ton guns, have been mounted in the battleship "Empress of India" (14), 14,450 tons, 13,000H.P., which is being prepared at Chatham for being commissioned.

An invention has lately been patented in Berlin for simplifying the shunting of railway carriages. The shock caused by the concussion of the buffers releases a catch, which falls into its proper position and prevents the sudden recoil which invariably accompanies shunting manœuvres. The inventor is an official at the Anhalter Station in Berlin.

It is stated that articles of steel and iron can be protected against rust by coating them electrolytically with peroxide of lead. A satisfactory coating can be obtained, it is said, in twenty minutes, and is perfectly proof against atmospheric influences. As the whole operation is conducted at ordinary temperature, the temper of steel articles is unaffected by it.

The French Government has suggested to England and the United States some improvements in shipping signals, which will probably be submitted to an international conference. It is proposed that the number of flags should be increased from 18 to 20, thus allowing the number of combinations to be increased from 78,642 to 123,500; and, secondly, that most of the flags taken separately should represent a particular word. The fact that the increase of speed reduces the time during which vessels going in opposite directions can exchange signals renders simplification necessary.

According to the report of the Director-General of Indian Railways for the past official year, the mileage open during the period under review was 17,000 miles of standard (5ft. 6in.) metre and special gauges, and the capital expended to December 31 upon open mileage charged to final heads, inclusive of steamboat and rolling stock, but exclusive of suspense items, was 213½ crores of rupees. The total earnings of all gauges amounted to 24 crores, and the expenses of working to rather over 11½ crores, leaving nearly 12¾ crores net earnings, equivalent to a percentage of 5·95 on capital expended.

Magnolia metal has recently been subjected to a practical test at the shipbuilding works of Messrs. W. B. Thompson Limited, Dundee. The test in question was made in the footstep-bearing of a grindstone 5ft. 10in. diameter by 12in. thick, the spindle running in Magnolia metal, the engine causing it to make 241 revolutions a minute. When at full speed the engine was stopped, but the stone continued to revolve for 70 minutes. The nearest result obtained by Messrs. Thompson from other metals tested under the same conditions was 45 minutes. This, it will be seen, is a very striking testimony to the anti-frictional nature of the Magnolia anti-friction metal.

The tenth meeting of the season of the Royal Scottish Society of Arts was held in the hall of the society, 117, George-street, Edinburgh, on the 10th inst., Mr. Charles A. Stevenson, B.Sc., M. Inst. C.E., in the chair. There was a large attendance. The second part of a paper on the utilisation of water for power was read by Mr. John Ritchie, hydraulic engineer, Edinburgh. The lecturer described the most modern appliances for obtaining power from water, and the theory of their action. He showed the difference between pressure and impulse turbines, and the particular application of each to varying falls of water; and an improved means of regulating the flow of water into turbines invented by the lecturer was illustrated by diagrams and models. A description was also given of several successful applications of water power for electric-lighting purposes carried out by Mr. Ritchie, with exceptionally high falls, one having a head of water of 650ft., and giving off 35H.P., the whole of the water being conveyed through a 6in. riveted steel pipe. An interesting discussion followed, and in reply Mr. Ritchie stated that the public were waking up to the fact that an enormous waste was taking place—a waste that was capable of being utilised to the benefit of the landowner and the manufacturer. It was also stated that several towns were contemplating the introduction of the electric light, the water entering the reservoirs under considerable pressure to supply the motive power, and that that arrangement had been at work in Greenock for some years.

The Musselburgh Wire Mill and Galvanising Works, near Edinburgh, are sending to the World's Fair samples of plough steel, patented rope wire, plated steel wire, galvanised hawsers, music and gun wire. There will also be specimens of a 40 per cent. tungsten steel billet. Each of the samples shown has been carefully tested, and the results are tabulated. Probably the sample of tungsten steel with 40 per cent. of tungsten is the only exhibit with such a high percentage.

Prize Competition.

WE OFFER FOUR GUINEAS MONTHLY IN PRIZES FOR THE BEST ORIGINAL ARTICLES SENT IN ON ANY MECHANICAL, ENGINEERING OR ELECTRICAL SUBJECT.

IN ORDER THAT MANAGERS, DRAUGHTSMEN, FOREMEN, AND WORKMEN WHO HAVE HAD NO PRACTICE IN WRITING MAY NOT HESITATE TO SEND IN COMPETITIONS, IT IS TO BE UNDERSTOOD THAT ALL ARTICLES WILL BE FULLY EDITED AND CORRECTED, AND JUDGED OF SOLELY ON THEIR MERITS AS ORIGINAL CONTRIBUTIONS FROM A PRACTICAL POINT OF VIEW. THE OBJECT OF THE COMPETITION IS TO INDUCE PRACTICAL MEN TO COME FORWARD AND GIVE THE RESULTS OF THEIR EXPERIENCE.

CONDITIONS.

Competitions for our Monthly Prizes must be sent so as to arrive at the Manchester Offices of THE MECHANICAL WORLD, New Bridge-street, not later than the last Tuesday in each month. Articles arriving after that time will be placed in the following month's competition.

Written competitions must be on one side of the paper only. The contributions must be original, and relate to matters connected with Engineering, Mechanism or Electricity.

The Proprietors of THE MECHANICAL WORLD reserve the right to publish any competition, whether it gains a prize or not.

The competitions may be accompanied by diagrams, sketches or drawings.

Competitors should write the words "Prize Competition" on the envelopes.

Competitors are not confined to one, but may send any number of competitions.

The correct name and address of the sender *must* be distinctly written upon every competition, not necessarily for publication. Competitions can appear under a *nom de plume.*

☞ We cannot undertake to be responsible for any MSS. sent to us, though when stamps are enclosed for the purpose we will endeavour to return rejected contributions.

Queries.

☞ **Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.**

☞ **Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.**

BRIGHTENING CHAINS.—Can any correspondent inform me what material to use in a shaker to brighten chains?—W. B.

WOOD'S AUTOMATIC PRESSURE RELIEF VALVE.—Required the address of Mr. W. Wood, the maker of the above.—B. AND Co.

COST OF M.S. AND L. RAILWAY.—Can anyone inform me what was the cost per mile of the M.S. and L. Railway from Manchester to Grimsby?—LOW DROP

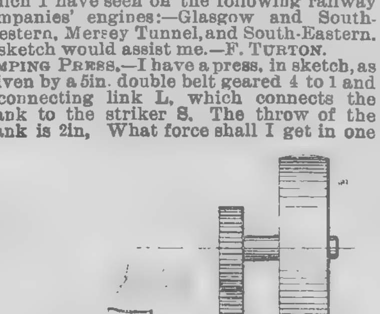
LOCOMOTIVE STAY TAPS.—Can any reader furnish me with the addresses of firms who are makers of locomotive stay taps suitable for fireboxes?—GEORGE.

DYNAMO.—Can any reader inform me whether a dynamo, wound to give 10 ampères at 55 volts at a given speed, would be damaged if driven at twice the speed, and, if not, what output would it give?—J. O.

POWER RENTAL.—I am desirous of supplying steam power to a tenant from an engine driving his own works. How is the value of such to be ascertained, and what is the fair price for 100I.H.P. per week of 54 hours; also for 8I.H.P. similarly supplied power?

STEAM REVERSING GEAR.—I should be much obliged if any reader will explain the working of a steam reversing gear for locomotives, which I have seen on the following railway companies' engines:—Glasgow and South-Western, Mersey Tunnel, and South-Eastern. A sketch would assist me.—F. TURTON.

STAMPING PRESS.—I have a press, in sketch, as driven by a 5in. double belt geared 4 to 1 and a connecting link L, which connects the crank to the striker S. The throw of the crank is 2in, What force shall I get in one



blow on the table A, and how shall I calculate the force if a fly-wheel is added, say 3ft. diameter and weighing 300lb? The thickness of the material to be stamped is $\frac{1}{16}$in., the depth about 3in., and the area of stamp 400sq. in.—YOUNG DRAUGHTSMAN

TUBBING.—What system ought to be adopted in the renewal of tubbing in a shaft which has become faulty in the middle of a length of tubbing 25 fathoms from the surface—pit 15ft. and 100 fathoms deep? Kindly explain what method to use to secure the greatest safety and make the most permanent work.—J. M.

METALLURGICAL FURNACE.—Can any reader furnish me with a scheme for supplying the heating power necessary for a metallurgical laboratory situated in iron-ore mining district, and where no gas is available? A small muffle furnace would be required, in addition to the ordinary heating power, and the fuel used is charcoal. Accommodation only required for one chemist.—H. S.

FACING SLIDE VALVE FACES.—I require a hand appliance, not expensive, suitable for getting up the faces of slide valves of portable, traction, and other engines, say when the valve face is some 3in. to 5in. from the valve-chest cover face. Are there no small hand-lever appliances which can be screwed on to a stud and used for working a broken file or similar tool?—NESCIENCE.

DYNAMO WINDING.—Can any reader oblige me with the proper winding for an E.P.S. type dynamo of the following dimensions (in centimetres), so as to obtain at least 4 volts 3 ampères at a speed of about 2000 revolutions per minute:—Length of magnet bar, 11; length of yoke piece, 8·4; width of magnet and yoke piece, 5·3 each; depth of yoke piece, 2·5; thickness of magnet bar inside bobbin, 3; diameter of armature, 5; length, 5·3; air gap, ½ millimetre all round? It has a laminated armature, with 12 interruptions $\frac{3}{16}$in. wide by ¼in. deep, and a corresponding number of sections in the commutator. The magnets are of Swedish cast iron. I have tried it with 2000 turns of No. 38 B.W.G. on the field and 120 turns of No. 26 B.W.G. on armature, but can get hardly any current.—E. P. S. TYPE.

Replies.

☞ **Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.**

☞ **Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.**

D. L. PATRICK.—About 7H.P.

J. C. BIRCHALL.—Address insufficient.

J. BOYLANG.—See reply to J. C. Birchall.

HYPER.—You do not say if the engine is condensing or not.

GAS ENGINE.—(1.) Either will do. (2.) A 6-horse nominal would give about equal power

S. B.—Apply to Brin's Oxygen Company, Horseferry-road, Westminster, London. S.W.

W. H. F.—Indiarubber is mixed with 2 to 10 per cent of sulphur and heated from 270 to 300 degrees.

MOULDER.—Apply to the Globe Engineering Company Limited, 38, Victoria Buildings, Manchester, mentioning this journal.

"URBS INTACTA."—(1. and 2.) To what kind of boiler do you refer? (3.) See page 35 of our issue for January 15, 1892. (4.) Hutton's "Steam Boiler Construction." (5.) Yes, very cordially.

P. A. T.—If the master has undertaken to teach you engineering and millwrighting, you are certainly entitled to claim that the rest of your time should be given to fitting. We do not, however, see how you can compel the master to adopt this course.

C. WOODHOUSE.—Rankine's "Civil Engineering," 16s.; Anglin's "Design of Structures," 16s.; "Pumps and Pumping Machinery," by Colyer; Hasluck's "Milling Machines and Processes," 12s. 6d.; "Bridge Construction," by Fiddler, 30s. All of these may be had from our office.

ENGINE PACKING.—Required the makers of the Britannia engine packing.—L. HULL.——*A.*—If "L. Hull" will kindly write A. E. Allen and Co., 37, Wellington-street, Hull, he will be supplied with full particulars anent Britannia engine packing.—O-SEAN.

RUST JOINTS.—How can I stop leakage in a vertical joint (rust joint) in my hot-water pipes (low-pressure system) without cutting out the packing? Would any fluid cement percolate into the crevices and harden there?—B.——*A.*—Mr. E. T. Atkins would like to communicate with you regarding stopping leakage in water pipes.

METALLIC PAPER.—Could any reader inform me how paper can be prepared for taking indicator diagrams upon, with brass or iron point, to give a clear erasure with the slightest pressure?—M. H. M.——*A.*—A metallic paper on which brass will mark can be prepared by painting ordinary paper with thick chalk and water. I have not tried erasure of these marks.—T. J. B.

COVERING TANK.—I have to cover in a brick water tank 50ft. long, 20ft. wide, with rolled joist and concrete. Will some reader kindly tell me the size of rolled joist required, the distance they should be apart, and the proportion of gravel and cement, and thickness of concrete? It is an open tank, and will have no weight to carry on the top.—S. D.——*A.*—If you cannot support your joists in the middle of the tank, you must use eight bays of 10ft. span. This means seven wrought-iron rolled joists 10in. by 5in., of about 36lb. per foot run, or lighter joists if of steel. The joists will then be 6ft. 3in. apart, centre to centre. They must be stayed apart by iron bolts or wooden struts at intervals of 5ft. or 6ft. so as to take the thrust of the concrete arches, which will rest on the lower flanges of the joists. These arches should have 1in. rise for each foot of span, and should not be less than about 5in. in the middle (at key). This will bring the crown of each arch about 1in. above the top of the joists. This amount can be filled in so as to make the whole top flush. The concrete must be built on strong centreing, and be rammed as laid, and the centres must be left in until the cement has thoroughly set. The concrete should be one to six or seven—*i.e.*, six or seven of shingle and sand combined to one of Portland cement. The shingle or pebbles should be washed, as well as the sand, before mixing to make good concrete. Be sure to get solid and strong abutments for the end arches, as the strength of the whole depends upon these.—T. J. B.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.
Where complete specification accompanies application, an asterisk is suffixed.

1st April, 1893.

6790 COMBINATION TOOL. C C Reynolds and E Brown.
6791 DOG for SAW MILLS. P Willis. (*J K and J E Junk*, United States.)
6792 STEAM GENERATORS. M and G Hise.
6800 ELECTRIC-LIGHTING APPARATUS for RAILWAY TRAINS and TRAMCARS. T J Flynn.
6805 SHADE for LAMPS or CANDLES SUITABLE for INCANDESCENT ELECTRIC LAMPS.* E W Streeter.
6808 JOINTING of TUBES to the TUBE PLATES of STEAM BOILERS. A McVicar.
6809 PUMPING MACHINERY. W Hunter.
6812 FRICTIONAL GEARING. C W Hollis.
6813 ELECTRICAL ARC LAMPS. F Bryan.
6814 DEPOSITION of COPPER on ORDINARY INSULATED CONDUCTORS. C R G Symthe and J Gordon.
6820 SECURING RAILWAY RAILS in CHAIRS. T Heppell and R Auton.
6821 STEAM PUMPS. T and W Toward and J Meek.
6822 SCREWING and TURNING MACHINES. O and J Sanders.
6827 METHOD of POLISHING WIRE. J Barber and J Haley.
6828 TREATMENT of SLAG. C W Thompson.
6836 COMPOUND LEVER or PLATFORM WEIGHING MACHINES. J S Pooley.
6837 MACHINERY for CARRYING, DRIVING and APPLYING SCREW-TAPPING or OTHER ROTATING TOOLS.* C M Davies.
6840 EXTRACTING GOLD and OTHER METALS from ORES. T Dobbie, jun.
6842 COMBINED REFUSE DESTRUCTORS and STEAM GENERATORS. J T Wood and J A Brodie.
6844 SAND MOULDING MACHINES.* H Vaughan.
6848 APPLIANCES for USING HIGH-PRESSURE STEAM for MOTIVE-POWER PURPOSES. J Murrie.
6851 APPARATUS for PLACING DETONATING FOG SIGNALS on RAILWAY LINES. W S Laycock.
6864 OIL and the LIKE HYDROCARBON MOTORS. J E Weyman.
6866 APPARATUS for VENTILATING, HEATING, and COOLING the INTERIOR of RAILWAY CARRIAGES. P Lawrence-Siegrist. (*F Verrue*, Belgium.)
6869 PIPES or TUBES.* G A Wayss.
6870 CUT-OFF MECHANISM for STEAM ENGINES. J Woods.
6876 DREDGING APPARATUS. F E Duckham.
6878 NUTS for BOLTS. A Urban.
6884 PIPES or TUBES.* C G Larson.
6885 ELECTRIC RAILWAYS.* H H Lake. (*M A Cattori*, Italy.)
6886 COMMUTATOR SWITCHES for USE in CHARGING ELECTRIC ACCUMULATORS. H H Lake. (*C Liebenow*, Germany.)

4th April, 1893.

6893 WASHER-PLUG for TAPS and VALVES. T B Wright and others.
6895 PACKING or COVERING and ARRANGEMENT of MATERIALS for ENVELOPING STEAM PIPES to PREVENT RADIATION of HEAT. J Murrie.
6918 SAFETY FOG-SIGNALLING APPARATUS for RAILWAYS. A Ganderton.
6921 MAGNETO-ELECTRIC GENERATOR with FIXED ARMATURE. T Rosati.
6922 DEVICES for ELECTRICALLY HEATING CRUCIBLES.* W Mitchell.
6925 MANUFACTURE of PAPER and APPARATUS for EFFECTING SAME. J Holden.
6928 PROCESS for MANUFACTURING SMOKE and PARTITIONED IRON or STEEL TUBES for STEAM BOILERS.* A Bère.
6929 GAS and OIL ENGINES. C Parker.
6930 SPRING WHEEL for LOCOMOTIVES and HEAVY WAGONS or CARRIAGES. G T Link.
6932 NON-CONDUCTING COMPOSITION for COVERING BOILERS, STEAM PIPES, ETC. W N Cook.
6933 WORKING of SIGNALS and LOCKING of POINTS ELECTRICALLY at RAILWAY JUNCTIONS. The Automatic Electric Railway Company Limited and E Blakey.
6935 METERS for MAKING MEASUREMENT of ELECTRICAL ENERGY. A G Brookes. (*H C Wirt*, United States.)
6936 PUDDLING FURNACES. H W Hollis.
6942 STEAM PUMPING ENGINES.* H H Westinghouse.
6948 CAR COUPLINGS.* J Bradford and E Lovelace.
6952 ELECTRICALLY-HEATED CRUCIBLES.* W Mitchell.
6951 CONSTRUCTION of PRIMARY ELEMENTS for PRODUCING ELECTRICAL CURRENTS by the MOISTURE and HEAT of the HUMAN BODY. A J Jarman.
6955 PACKING for PISTON RODS.* C S Dean.
6956 CAR COUPLERS.* J L Myers.
6958 WORK HOLDERS for CLAMPING DEVICES.* H Binsee and J P Hauschild.
6965 ELECTRIC FURNACES. R Urbanitrky and A Fellner.
6968 FRICTION CLUTCHES or POWER TRANSMITTERS. W H Lindsay.
6975 APPARATUS for PERIODICALLY COMPLETING and INTERRUPTING ELECTRIC CIRCUITS. E L Berry and F Harrison.

5th April, 1893.

6979 MACHINES or MECHANISM for SAWING or CUTTING STONE. C H Firth.
6985 HOT WATER and STEAM BOILERS for HEATING APPARATUS. J KITCHEN.
6998 HEATING of BOILERS or VESSELS by GAS or OIL FLAMES. D Dickson and J R Wilson.
7002 COMBINED GAS and COKE FURNACE.* H Schomburg.
7004 FLEXIBLE HOSE PIPES. J Germain and others.
7005 ELECTRIC ACCUMULATOR PLATE. R F Yorke.
7016 HYDROSTATIC WEIGHING MACHINES. W Smith.
7020 ELECTRO-MAGNETS. J A Kingdon.
7024 SIGNALLING on RAILWAYS when FOGS are PRESENT. J A F Aspinall.
7025 FLEXIBLE HOSE.* J E Hopkinson.
7028 PAPER MACHINES.* P Jensen. (*C Eichhorn*, Germany.)
7031 PUMP. W G Checkett.
7018 LOCOMOTIVE BOILERS. J S Newlin and J F Lightsey.
7055 MECHANISM for CONVERTING RECIPROCATING MOTION into ROTARY MOTION, and VICE VERSA. G Humphries.

6th April, 1893.

7064 GAS and SIMILAR MOTOR ENGINES. A R Bellamy.
7069 FITTING TELEPHONE INSTRUMENTS. A E Field.
7072 APPARATUS for PROPELLING SMALL BOATS. W K Carew.
7076 VENTILATORS. J Honeyman.
7078 VENTILATORS.* G F Redfern. (*W M'Farlane*, Canada.)
7082 FLEXIBLE BRACKETS for ELECTRIC LIGHTING. F W Ketley.
7085 APPARATUS for PRODUCING INTERMITTENT ELECTRIC FLASH-LIGHT SIGNALS. O E Wheeler.
7097 RAILWAYS. G W Doolittle.
7101 APPARATUS for USE in CONNECTION with ELECTRICAL TRANSFORMERS. F H Medhurst and W J Hope-Johnstone.
7105 TOOL for TURNING or EQUALISING EMERY WHEELS. J Urbanek.
7117 APPARATUS for the MANUFACTURE of METALLIC PIGMENTS or COMPOUNDS. A C J Charlier.
7118 ZINC OXIDE, CARBONATE of ZINC, and COMPOUNDS of these with LEAD PIGMENT. A C J Charlier.
7119 APPARATUS for the MANUFACTURE of METALLIC PIGMENTS or COMPOUNDS. A C J Charlier.
7120 FUEL ECONOMISERS or FEED-WATER HEATERS. J G Calvert.
7124 HYDRAULIC APPARATUS for the PRODUCTION of FORCE. M Cherpin.

7th April, 1893.

7131 HEATING WATER for STEAM BOILERS by the EXHAUST PRODUCTS of COMBUSTION. J Murrie.
7136 MACHINES for the MANUFACTURE of NAILS. T Gare.
7133 FURNACE FIRE-GRATE for COMPLETE COMBUSTION of FUEL. J Williams.
7147 RAILWAY CARRIAGE HEATING APPARATUS. G T Wheatley.
7150 THERMOMETERS for REGISTERING LOW TEMPERATURES. A Shiels.
7151 HUMIDIFIERS. A Shiels.
7153 UTILISATION of TIDAL FORCE for the OBTAINMENT of MOTIVE POWER. G J Cole.
7154 POINTS or SWITCHES of TRAMWAY and RAILWAY LINES. J W Littlejohn.
7156 LUBRICATORS for TRANSMISSION BELTS. S S Woodbury.
7157 CLEANER for TUBES. J C Stewart.
7160 SELF-ACTING TEMPERATURE REGULATORS.* E H C Oehlmann.
7168 FERRULES for PROTECTING BOILER TUBES. A Turnbull.
7172 CAR COUPLINGS.* J M Stark.
7176 CAR COUPLERS.* A J Boult. (*J H Coleman*, Canada.)
7183 APPARATUS for SUPPLYING PAPER and OTHER FABRICS with PASTE and OTHER LIQUID CEMENTITIOUS MATTER.* J Foster and others.
7190 MAGNETIC PARTS of ELECTRICAL APPARATUS. A G New.
7192 GUARDS for ELECTRIC and OTHER LAMPS. J Eaton-Shore.
7194 IMPROVEMENTS in VEHICLES RUNNING ON RAILS, APPLICABLE TO ELECTRIC TRACTION, and ADAPTED to PASS AROUND CURVES. G Averly.
7199 PORTABLE ELECTRIC LAMP APPARATUS. S Hellebrandt.
7203 FURNACES. C J Chubb.
7204 PACKING RING.* C Sohrmann.
7208 STEAM BOILERS. E T Bousfield.
7213 CONCENTRIC ELECTRIC CONDUCTORS. J S Raworth and T O Callender.

8th April, 1893.

7220 FRICTION CLUTCHES for DRIVING MACHINERY. W T Howroyd and others.
7223 CHAIRS for RAILWAY SWITCHES, CROSSINGS, and RAILS. C W E Marsh and R Laybourne.
7225 STEAM ENGINES. J Maxton and H MacColl.
7234 BRICK-MOULDING MACHINERY. R A Norris.
7240 SCREW PROPELLERS. T Andrews.
7241 CHISELS for MORTICING. J Horton and others.
7247 CAR COUPLINGS.* W E Gedge. (*F M Ryan* and *W T Smith*, United States.)
7258 WOOD EMBOSSING MACHINES. W P Thompson. (*M B Crist*, United States.)
7262 CONTINUOUS ROTARY LEVER. A Angell.
7266 DISTRIBUTION of ELECTRICAL ENERGY. J Whitcher.
7279 COMPOUND LOCOMOTIVE ENGINES. K Gölsdorf.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 3d. each) to SIR H. READER LACK, Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

All who are practically engaged in Mechanical Engineering or Scientific Industries are invited to avail themselves of THE MECHANICAL WORLD columns for information. We are glad to help the diffident, and, so far as we can, remove the obstacles which frequently prevent practical men from communicating their ideas.

We wish it to be distinctly understood that we cannot, for any consideration, and will not knowingly, allow our editorial columns to become the vehicle for mere advertisements of machinery, apparatus, or anything that falls within our province to notice.

Every correspondent should forward his name and address, not necessarily for publication unless so desired. We do not undertake to return MSS. unless specially requested, and in such cases stamps should always be sent.

All communications relating to editorial matters should be addressed to the Editor of THE MECHANICAL WORLD, at the Manchester, and not the London, Offices.

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6s. 6d. a year, 3s. 6d. half-year, 2s. per quarter, in advance, postage prepaid, in the United Kingdom
8s. 8d. a year to Foreign Countries postage prepaid.

☞ Owing to the large demand for back numbers of THE MECHANICAL WORLD, we are compelled to fix the following scale of prices:—Copies published in 1887, 6d. each; 1888, 5d.; 1889, 4d.; 1890, 3d.; 1891 and first half of 1892, 2d. each.

All remittances payable to EMMOTT AND COMPANY LIMITED, Publishers, either at New Bridge Street, Manchester, or 85, Strand, London, W.C.

FRIDAY, APRIL 28TH, 1893.

Lighting in the Metropolis.

IF further confirmation were needed of the justice of the remarks contained in our last issue concerning the unwise policy of constructing huge central electric-light stations, and equipping them with plant far in excess of their possible future requirements for several years, it is to be found in the progress made by the Metropolitan Electric Light Company since its inception in 1888. Taking over on its formation the Whitehall-court station, the company has since then built four large generating stations, and fitted them up with boilers, engines, dynamos, and instruments mostly of different types, and in this manner valuable experience has been gained. The area over which the company has lighting powers is larger than that of any other concern in London. As showing the marked advance made in the different districts, an interesting wall diagram was exhibited at the sixth ordinary general meeting of the company, held on Friday last. According to the diagram, the number of incandescent lamps supplied by the company, and reduced to a uniform lamp of 8 candles, was 10,600 in 1889; 48,000 in 1890; 82,000 in 1891; and 124,000 at the end of 1892; whilst down to the middle of April the number has been increased to 135,274. These figures show how constant is the rate of increase, and applications for connection to the mains continue to exhibit a steady progress. The income per lamp installed is, however, a varying quantity. In the case of restaurants and other establishments where the business hours are of long duration, the yield is as much as 30s. a lamp per annum. On the other hand, according to Sir John Pender, the chairman of the company, many private consumers only average about 2s., or even less than that, per lamp per annum; whilst in one or two extreme cases the return is only 4d. per lamp installed! Apart from these wide differences of earning powers, it is important to note that while the income from the sale of current has increased by 35 per cent., the cost of production has only risen by 4 per cent. We do not think it has ever been mentioned previously by any of the chairmen of the London electric-light companies that the annual income per lamp installed has been as low as 2s.—leaving the fourpenny lamp out of the question. Of course, some lamps are only used on special occasions; but in the case of lighting it is really the average receipts per lamp connected which should be seriously considered. It is all very well for Sir John Pender and others to speak of the probable income which may be realised by the sale of current for motive-power purposes during the daytime—that is, when the load at the stations is at the lowest; but why do they not endeavour to cultivate a day load? Electric grills and other electrical cooking apparatus are well in their way, but they are as yet, with the present price of current, more expensive than the coal or coke-fired cooking appliances now in existence, and for that matter the return from the supply of current in such cases would be trifling. Why not endeavour, by a reduction in the price per unit to say half price—as in the case of the St. Pancras Vestry at 3d. per Board of Trade unit,—to promote the use of electromotors for operating lifts, coffee-grinding machines, etc., and which are of more importance to a supply company? If a day load is to be well maintained, it can only be done by the supply of power, and what steps, we would ask, does any concern take to attain this object? Practically none. If, however, the concerns in question will make local demonstrations of the advantages of electric power—shown applied in different cases—they will find the day load increase and a better return for all concerned.

Railway Accidents in 1892.

FROM the returns recently issued it appears that the total number of persons killed on railways in the United Kingdom last year was 1204, while 10,476 were injured. These figures include the persons killed and injured on railways in the course of public traffic, as well as those killed or injured in accidents which occurred upon the premises of the companies, but in which the movement of rolling stock was not concerned. The latter class was responsible for the death of 74 persons and the injury of 5991, and does not affect the proportion of accidents and casualties which occurred under the former category. The return of the latter class shows that the record for last year compares favourably with that of 1891, and although the number of deaths was larger than in 1890, the number of persons injured was considerably less than for several years past. Amongst the cases reported, but which involved no personal injury, are included 523 failures of tyres, one failure of a wheel, four cases of the failure of bridges, and 272 failures of rails. Of the 523 tyres which failed, 20 were engine tyres, 11 were tender tyres, two were carriage tyres, 13 were van tyres, and 47 wagon tyres. Of the 257 axles which failed, 165 were engine axles—viz., 130 crank or driving, and 35 leading or trailing; 24 were tender axles, four were coach axles, and 64 were wagon axles; 25 wagons belonged to owners other than the railway companies. Of the 130 crank or driving axles, 35 were made of iron and 95 of steel. The average mileage of 31 crank or driving axles made of iron was 242,136 miles, and of 75 crank or driving axles made of steel 291,289 miles. Of the 272 rails which broke, 107 were double headed, 146 were single headed, 17 were Vignoles rails, and two were bridge rails; of the double-headed rails, 81 had been turned; 15 rails were made of iron, 256 of steel, and in one case the material was not stated.

Lighting of Munich.

AN important scheme for utilising waterpower is assuming definite form in Munich. A small installation, using an insignificant quantity of the power of the river Isar, is already at work near Höllriegelsgereuth, and it has now been decided to increase the plant and transmit the power electrically to Munich for lighting and motive-power purposes. As far as can be at present judged, there will be a large demand for current for operating small motors, since in Munich, in contradistinction to most other towns of the same size, there are numerous small industries which need cheap motive power, which, by the use of the Isar, it is expected will be afforded them. In addition to this, the prospects of working the tramway electrically are said to be good. The generating station will be primarily built to deal with 1900H.P., and to be extended to 3800H.P. Alternating-current machines will be used, and the current will be transmitted to a distributing station in Munich; the latter, by the provision of steam dynamos, will supplement the former and partly act as reserve. This combined plant, with the addition of other water-power in the locality, will bring up the total to 7200H.P. It has as yet not been decided whether the town itself or a company shall undertake the work.

Compound Blowing Engines.

THE increasing production of hematite in place of ordinary Cleveland pig iron is occasioning a change in the engines used for blowing purposes in the Cleveland district. Formerly, when a plentiful supply of waste gas was available, manufacturers could afford to disregard all questions of steam economy; but now, under the altered condition of things, they find their waste gases small in quantity and poor in quality, so much so that in many cases coal has now to be used as a supplementary fuel. In a paper recently read by Mr. Westgarth, of the firm of Messrs. Westgarth, English and Co., Middlesbrough, a description is given of the conversion of three ordinary blowing engines into compound-condensing engines. The result of the change is that the owners are now blowing an average pressure of 5½lb. to 6lb., and although only four furnaces are at work, and two of them upon hematite, the actual output is 2720 tons, as against 2780 tons from five furnaces before the alterations, and it is now only necessary to use 17 boilers, as against an average of 20½ employed before the alterations. The saving of the number of boilers in use, while making practically the same quantity of iron, and with an increased total indicated horse-power, is a very convenient and tangible method of measuring the economy effected by altering the engines, and will doubtless appeal very forcibly to other makers in the district who are similarly circumstanced.

A New Steel-making Process.

IT is reported that a new process of steel making has been patented by the Phoenix, Ruhrort, and the Dudlingen Ironworks, in Luxembourg. These concerns have been experimenting for years with the object of finding out an improved method of introducing the necessary carbon into the molten metal bath. The problem is now said to have been solved by mixing pulverised anthracite and lime water together, and forming the mass into briquettes under great pressure; these briquettes are then brought into contact with the molten metal, and in this way exactly the desired proportion of carbon for the formation of steel of various tempers and qualities can be imparted in the converter. The Burbacher Hutte, as well as the Dudlingen Works, have been practically working the process for some time. The costs of this method of recarbonising are said to be only about one-sixth those of the old ferro-manganese process, but the chief advantage is stated to be the greater accuracy and uniformity with which any required quality of steel can be produced, ranging from the hardest to the very toughest sorts. The patentees anticipate that rails made on the new system will have a life of from 35 to 40 years.

Coal-dust Motive-power Engines.

A NOVEL motive-power engine has been patented by a German engineer, and, according to report, Herr Krupp is now constructing a number of experimental engines to test the practicability of the scheme. The idea is to turn to useful account the fact that finely-divided carbonaceous matter floating in the air readily explodes, and to adapt this to the generation of motive power the inventor proposes to grind coal to an impalpable powder, and, after introducing the dust floating in the air into the cylinder of an engine, explode it, the idea being to follow very much the same lines which are being so thoroughly developed in the use of gas in engine practice. The first difficulty which suggests itself is how the ash is to be got rid of, but Herr Krupp says that his experience in gun manufacture convinces him that this is not a serious obstacle. The advantages which would grow out of a direct utilisation of mineral fuel as mined are very obvious. While modern practice converts only 10 to 15 per cent. of the heat energy stored in coal into power at the crankshaft of a steam engine, it is claimed that no less than 75 to 80 per cent. could be made available by the direct combustion of the fuel through explosion of coal dust.

The Mannesmann Process of Seamless Tube Rolling.

(*Continued from page* 133.)

WHEN no core is used, and the compression brought to bear on the blank from without is in itself sufficient to produce the desired hole, the surface of such hole is rendered smoother and more uniform by two agencies, to wit:—

1. The twist of the fibres—hereinafter called the frictional twist—which is comparatively slight, and is induced by the mere friction of the blank against the rollers; and

2. The twist of the fibres—hereinafter called the heteroclitic twist—which is induced by projections upon the surface of the rollers, and by the grooving or roughing of such surfaces. The more the fibres are twisted while the hole is being formed the more uniform the surface of the hole must be, for the following reasons:—(*a*) All blisters, honeycombs, and other deformities in the material are drawn out, and their injurious character is proportionately reduced; (*b*) these irregularities assume a concentric order, which neutralises the warping or deflection of the material, in a certain measure at any rate, when it is

being hardened; (c) while the rolling of pipes is going on a rupture takes place at the mathematical centre, and the hole thus formed is being enlarged, or the blank, while revolving between the rollers, is flattened out to some extent. Owing to the fibres being constantly twisted, or their position toward each other being otherwise constantly changed, the material is always strained in one direction or another, and the honeycombs, which under other circumstances would be superadded to one another, constantly cross each other, and are thereby prevented from obtaining a notable depth. If the dimensions and proportions be properly chosen in accordance


FIG. 18

with experimental practice, pipes may be produced without the use of a core by the mere rupture of the interior, and in such a way that the sides of the hole are comparatively smooth and perfectly free from blisters or honeycombs.

In the event of the material worked upon not being homogeneous, or of there being irregularities, blisters, or pores in billets or rough rolled pieces, or of the sides of pipes or tubes of any description not being of uniform thickness throughout, the frictional, or, by preference, the heteroclitic twist of the fibres may be turned to account for the purpose of giving the sides of the finished pipes a uniform thickness in every direction, or of compelling an exactly central position of the core while the rolling process is going on. By means of this twist the fibre of the metal or other material may be stretched and reduced in thickness during the rolling, such reduction being in excess of the reduction that takes place in the diameter of the blank. By this method an amount of strength may be obtained, even in the case of thick pieces, such as could heretofore be obtained only in producing thin pieces by rolling; and in thick pieces better-stretched and more uniform fibres are obtained, or else a more delicate grain in the case of granular metals, such as steel and iron.

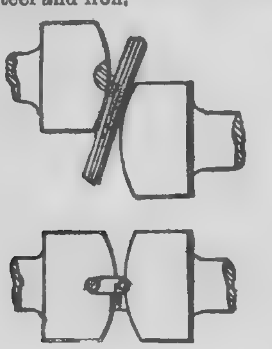


FIG. 19

If the blank be heated so rapidly that the interior remains cold, and consequently offers a greater resistance to torsion than the outside, the outside is twisted much more sharply than the inside when the material is subjected to a frictional or, by preference, to a heteroclitic twist. In this case the fibres do not merely undergo a rope-like twist around the longitudinal axis of the blank, but the external layers of the material, which have the same cross section, also undergo a marked displacement towards the corresponding internal layers. By this means blisters, honeycombs, or similar irregularities are extended in the direction of the periphery and compressed in such a way as to assume an approximately concentric order. By applying the brake or reducing the speed at

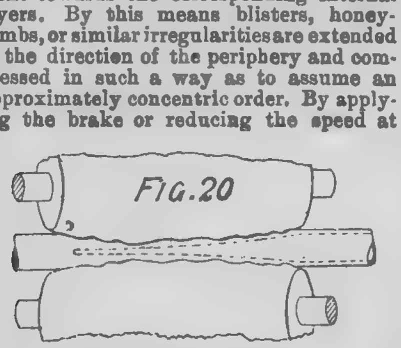


FIG. 20

which the thicker portion of the blank rotates, the internal layers may have a more or less sharp twist given to them in proportion to the external layers.

In those cases in which the fibres of a blank have been twisted in one direction and a twist in the opposite direction is imparted to them at the following operation, the first twist is wholly or partly neutralised by the second, and the stratification of the fibres that results therefrom will be straight, curvilinear, zig-zag, or otherwise shaped, according to circumstances. The second twist may also be effected in one heat with the first, if two or more sets of rollers be worked in succession, or if different directions be given to the motion of the various portions of the same set of rollers or different speeds imparted to them, as will be the case when the blank, after it has been inserted between the rollers, first rotates slowly, then is made to revolve at a more rapid rate, and eventually has its speed reduced again towards the egress. In Fig. 18 this stratification of the fibres is illustrated in the shape of a pipe rolled out of a solid block, and having remained solid at one end. The lines are intended to show how in such a case the fibres first turn to the right and then to the left.

A second twist of the fibres in a direction opposite to that of the first twist also takes place if the first rollers cause the piece to rotate at a uniform speed while the second rollers cause it to rotate at a gradually reduced rate of speed. Such is the case when conic rollers or rollers in the shape of face plates are used. With some materials the process may be repeated *ad infinitum*, so much so that very complicated configuration may be produced thereby.

If in the case of oblique rolling—that is to say, when a rotatory and at the same time rectilinear motion is imparted to the blank, or in the case of cross rolling—that is to say, if the blank be rolled while revolving between two rollers moving in opposite directions, but without the blank progressing automatically,—projections or notches be made on the surface of the rollers, to admit of the blank being grasped more firmly, there is an approximate uniformity in the superficial speed of the blank and of the rollers in the points of contact, and there is less sliding and consequently less wear and tear of the rollers; it also becomes easier to draw the blank into the rollers. If in the arrangement Fig. 20 the cone at the rollers be formed very gradually, a solid blank may be rolled into a pipe of a larger diameter even without using a core; and if the solid blank be properly gauged, it may even be made into a thicker solid piece between the rollers. It stands to reason that the two processes may be merged into one—that is to say, the operation of drawing out a thick piece to narrow dimensions, and that of thickening a piece of smaller dimensions. When this is to be done, the rollers must be so gauged and turned, while leaving the rest of the apparatus untouched, that towards the egress the material will proceed at a less rapid rate than in its thinnest part. This is effected by means of sharp projections made on the surface of the rollers, and gearing, as it were, into the blank, thereby forcing the material back. This process can also be expedited by artificially reducing the speed at which the blank rotates in proportion to that of the movement of the rollers. The projections shown in Fig. 20 become narrower towards the egress, and it is best to choose the proportions in such a way that the projections always bear upon the corrugations upon the surface of the blank which are nearer to the egress. By passing once through these rollers, the fibres of the blank grow more interwoven, and the structure of the metal becomes more homogeneous. This method of rolling produces practically the same effect as is achieved in the case of refined steel by repeated welding in pockets and by other kindred operations. The process may also be used for welding iron, for the purpose of relieving it more completely of scoria by drawing out very thin while twisting its fibres at the same time. In this case, the result is more favourable than it is with very thick blanks, and yet the piece worked upon may in the end be rolled solid or hollow to exactly the required diameter.

(*To be continued.*)

Machine Construction.

THE CONSTRUCTION OF MACHINE ELEMENTS.

(*Continued from page* 133.)

§ 162.

LEVER ARMS OF RECTANGULAR SECTION.

THE calculations of the dimensions of simple lever arms of rectangular section are made upon the assumption that the force P acts in a plane, passing through the middle of the arm, Fig. 459, and in a direction normal to the arm.

If we let

h = width of the arm at the axis,
b = thickness of the arm at the axis,
S = the maximum permissible stress,

$$b = 6\,\frac{P\,R}{S\,h^2}.$$

Taking S for wrought iron = 8500, and for cast iron = 4250, we have:—

For wrought iron: $b = 0{\cdot}00072\,\dfrac{P\,R}{h^2}$.

For cast iron: $b = 0{\cdot}00144\,\dfrac{P\,R}{h^2}$ ...(153)

These formulæ are adapted for the determination of b when h has been selected, the latter being most conveniently chosen with regard to the other condition.

Example 1.—Let P = 4400lb., R = 24in. for a lever arm of wrought iron, and N = 7⅛in. we have from (153):—

$$b = 0{\cdot}00072\,\frac{4400 \times 24}{(7{\cdot}125)^2} = 1\tfrac{1}{2}\text{in.}$$

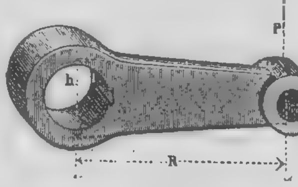


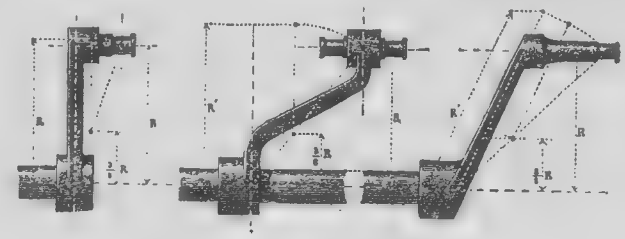
FIG. 459.

If b is kept constant for the whole length of the arm, the width at the small end may be 0·5 h, while if a constant ratio of $b : h$ is kept, the small end = ⅔ h (see § 10, Case III. and VII.).

If the force P does not act in the middle plane, as often occurs, then there must exist a combined bending and twisting stress on the arm. We may then derive a combined stress whose bending moment will give an ideal arm R′.

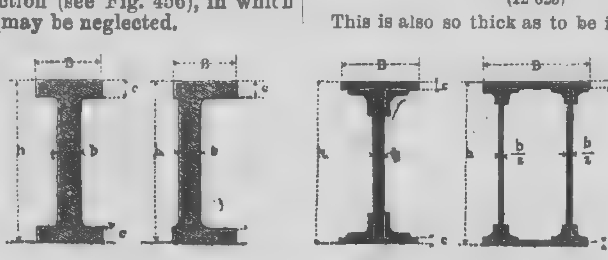
If the plane in which the force P acts is distant from the middle of the arm by an amount c, we may make approximately, (see § 150):—

$$\left.\begin{array}{l} R' = \tfrac{3}{8}\,R + \tfrac{5}{8}\sqrt{R^2 + c^2}\ ;\ \text{or} \\ R' = 0{\cdot}975\,R + 0{\cdot}25\,c.\ \ \text{If} \\ R > c,\ \text{and} \\ R' = 0{\cdot}625\,R + 0{\cdot}6\,c,\ \text{is} \\ R > c. \end{array}\right\} \ldots(154)$$


MACHINE CONSTRUCTION.—FIG. 460.

R′ may be determined readily by the graphical method, Fig. 460. The third case shows the method for inclined arms.

Cast-iron arms are sometimes made of cruciform section (see Fig. 456), in which case the ribs may be neglected.


MACHINE CONSTRUCTION.—FIG. 461.

§ 163.

LEVER ARMS OF COMBINED SECTION.

The sections shown in Fig 461 are designed to secure an economy of material. Their dimensions are readily determined by first calculating a corresponding arm of rectangular section, and then transforming it into an I section, or double II shape. If h_0 be the depth and b_0 the breadth of the equivalent rectangular arm, and h and b the corresponding terms to be found as in Fig. 461, we have

$$\left.\begin{array}{l} \dfrac{b}{b_0} = \dfrac{1}{1 + a} \\ \text{in which} \\ a = \left(\dfrac{B}{b} - 1\right)\left[\,6\dfrac{c}{h} - 12\left(\dfrac{c}{h}\right)^2\right] \end{array}\right\} \ldots(155)$$

These formulæ permit a choice of the ratios $\dfrac{B}{b}$ and $\dfrac{c}{h}$, which may be left to the judgment of the designer. In (155) the angle irons of the third example in Fig. 461 have been neglected, and may be considered as making up for the weakening of the rivet holes. The following table gives a series of values for (155) which will simplify the calculations materially. The table will also be found useful for other purposes, as all sorts of beams, crane booms, etc.

§ 164.

TABLE FOR TRANSFORMING ARM SECTIONS.

$\frac{h}{c}$	Values of $\frac{1}{1+a}$: $\frac{B}{b}$ = 2·5	3	3·5	4	4·5	5	6	7	8	10
6	0·50	0·43	0·38	0·33	0·30	0·27	0·23	0·20	0·18	0·14
7	0·52	0·45	0·40	0·35	0·32	0·29	0·25	0·21	0·19	0·15
8	0·54	0·47	0·42	0·37	0·34	0·31	0·26	0·23	0·20	0·16
9	0·56	0·49	0·44	0·39	0·36	0·33	0·28	0·24	0·22	0·18
10	0·58	0·51	0·46	0·41	0·37	0·34	0·29	0·26	0·23	0·19
11	0·60	0·53	0·48	0·43	0·39	0·36	0·31	0·27	0·24	0·20
12	0·62	0·55	0·50	0·44	0·41	0·37	0·32	0·29	0·26	0·21
14	0·64	0·58	0·52	0·47	0·44	0·40	0·35	0·21	0·28	0·23
16	0·67	0·60	0·55	0·50	0·47	0·43	0·38	0·34	0·30	0·25
18	0·69	0·63	0·57	0·52	0·49	0·46	0·40	0·36	0·33	0·27
20	0·71	0·65	0·60	0·55	0·52	0·48	0·42	0·38	0·34	0·29
22	0·73	0·67	0·62	0·57	0·53	0·50	0·45	0·40	0·37	0·31
24	0·75	0·68	0·64	0·59	0·56	0·52	0·47	0·42	0·38	0·33
27	0·76	0·71	0·66	0·62	0·58	0·55	0·50	0·45	0·41	0·35
30	0·78	0·73	0·68	0·64	0·61	0·57	0·52	0·47	0·43	0·37
33	0·79	0·75	0·70	0·66	0·63	0·60	0·54	0·50	0·45	0·39
36	0·81	0·76	0·72	0·68	0·65	0·61	0·56	0·52	0·48	0·41
40	0·83	0·78	0·74	0·70	0·67	0·64	0·58	0·54	0·50	0·44
45	0·84	0·80	0·76	0·72	0·69	0·66	0·61	0·57	0·53	0·47
50	0·85	0·81	0·78	0·74	0·71	0·68	0·63	0·59	0·56	0·49

Example 1.—A lever arm has a length R = 78·75in., and the journal pressure at the end = P = 5500lb. It is to be of cast iron of double T section with a height h_0 = 12⅝in. According to (153) we have for a rectangular section

$$b_0 = 0{\cdot}00144\,\frac{5500 \times 78{\cdot}75}{(12{\cdot}625)^2} = 3{\cdot}9\text{in.}$$

This is also so thick as to be impracticable and hence the double T section may be compared. Here we take $c : n = 1 : 12$, $B : b = 4$, and we get from the table $\dfrac{1}{1 + a} = 0{\cdot}44$ and $b = 0{\cdot}44\,b_0$ = 1·71in., and the flange breadth B = 0·44 b = 1·71 × 0·44 = 0·752, the web thickness = $c = \frac{1}{12} = h = \dfrac{12{\cdot}625}{12}$ = 1·05in., all of which are practical dimensions. It may be found desirable to have $c = b$, or any reasonable ratio for B : b, and $c : h$ be chosen.

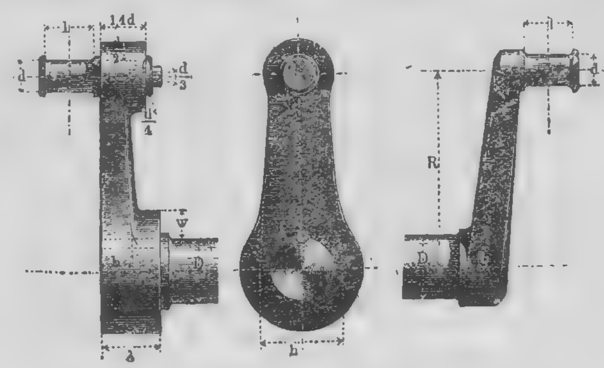


FIG. 462.—MACHINE CONSTRUCTION.—FIG. 463.

Example 2.—A wrought-iron arm has been found to require b = 2⅜in., h = 12⅝in. It is desired to make $\dfrac{b}{b}$ = 0·25, and in column 10 we find 0·25 opposite $\dfrac{h}{c}$ = 16. Hence b = 0·57in. and B = 10 × 0·57 = 5·70in. and $c = \dfrac{12{\cdot}625}{16}$ = 0·8in.

CHAPTER XII.

CRANKS.

§ 165.

VARIOUS KINDS OF CRANKS.

Cranks are those forms of simple levers which are so arranged that they may,

together with their various connections, make entire and repeated revolutions about an axis. These may be divided into the following four classes :—

1. Single overhung cranks.
2. Return cranks.
3. Double cranks, or cranked axles.
4. Eccentrics.

These will be briefly treated in succession.

§ 166.

SINGLE WROUGHT-IRON CRANKS.

These cranks may be proportioned according to the rules given for simple levers and rocker arms (§ 159 *et seq.*). Fig. 462 shows the usual form ; the arm tapers to two-thirds its base dimensions both ways, and is made slightly convex on the back. The crankpin is forced or driven in, and secured with a cap bolt. Fig. 463 shows a crank forged in one piece. In this case the width of the arm at the base is determined by the necessary amount of shoulder on the shaft. The proportions of the pin are obtained from the rules in § 159.

(To be continued.)

Mechanical and Engineering Drawing.—XI.

BY A PRACTICAL DRAUGHTSMAN.

IN the construction of the preceding plane figures, the lengths of one or more of their sides, with their relation to each other, are previously known or determined by the given problem. In the case of a regular *polygon*, the data generally given are its *kind*, and the length of a side, or a given circle within which it is to be inscribed. The ordinary solution in such cases involves the remembering of certain specific constructions which are liable to be forgotten when most needed. All that is absolutely required to be known for the construction of *any* regular polygon, is the

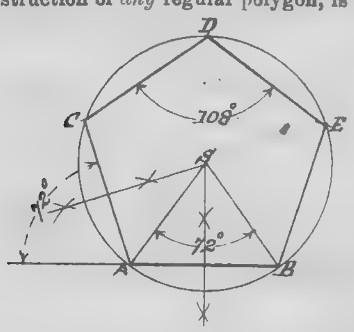


FIG. 67.

relative position of any two of its adjacent sides, and in certain cases the *length* of one of them.

The relative position, or, in other words, the *angles* made by any two adjacent sides of a regular polygon, are easily determined. The *exterior* angle, or that formed by one side with the other produced, is always equal to 360° divided by the *number of the sides* of the polygon, and the *interior* angle, or that formed by the meeting of the two adjacent sides, is 180° minus the exterior angle. The angle at the centre (or central angle) of a regular polygon is equal to the exterior angle. With these simple facts committed to memory, the student or apprentice can, with a scale of chords—now generally found on all pocket rules,—

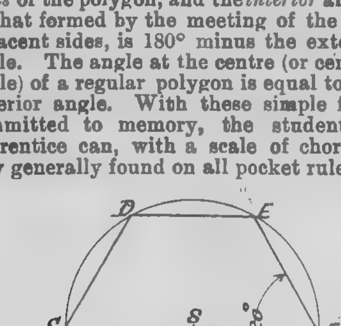


FIG. 68.

lay down at once on his work any regular polygon having either an odd or an even number of sides. To apply these facts we will take :—

Problem 19 (Fig. 67).—To construct a regular *pentagon* with a given length of side? Here 360° ÷ 5 equals 72°, the exterior angle; and 180° − 72° = 108°, the interior. Let A B be the given side, produce it (say to the left) at A, draw the line A C, making an angle of 72° with A B produced, and of a length equal to A B ; bisect A B and A C by perpendiculars intersecting in S, then S is the centre of the circumscribing circle. Describe it, and from C, with A B as a distance, set off on it the points D, E, join C D, D E, E B, and A C D E B is the required pentagon.

If the pentagon has to be *inscribed* in a given circle, then from its centre—which will be the centre of the pentagon—draw any radius as S A (Fig. 67) at S, draw a line making with S A an angle of 72°, and cutting the circle in B, join A and B, then A B is one side of the required pentagon ; set off the distance A B from A or B round the circle, and it will give points C, D, E ; join A C D E B, and the pentagon is constructed in the given circle.

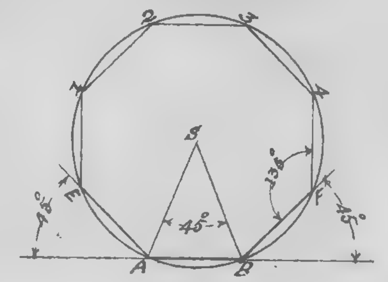


FIG. 69.

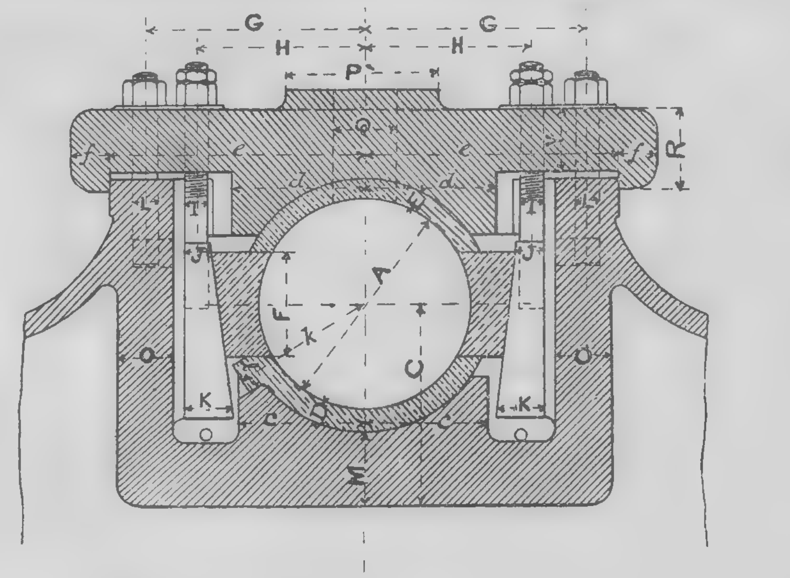
Problem 20 (Fig. 68).—To construct a regular *hexagon* with a given length of side? Here 360° ÷ 6 equals 60°, and 180° − 60° = 120°. Let A B be the given side, produce it, and draw A C, making with A B produced an angle of 60° ; make A C equal to A B, bisect them by perpendiculars intersecting in S, which is the centre of the circumscribing circle ; describe it, and set off the distance A B round it from C, in points D, E, F, join C D, D E, E F, F B, and the required hexagon is constructed. If a hexagon has to be *inscribed* in a given circle, the central angle will be 60° ; this angle laid down with the centre of the circle as the angular point will give A, B, (Fig. 68), points in the circle, and the line joining them will be a side of the hexagon ; step this length round the circle in points C, D, E, F, join A C, C D, etc., and the required hexagon is inscribed in the given circle. As the side of a hexagon is the chord of an arc of 60°, and is equal to the radius of the circumscribing circle, that radius set off round the circle will divide it into six equal parts, and if the points of division be joined by right lines they would form the inscribed hexagon as before.

Problem 21 (Fig. 69).—To construct a regular *octagon*, with a given length of side? Here 360° ÷ 8 = 45° ; and 180° − 45° = 135°. Let A B be the given side. Produce it in both directions, and at A and B draw lines A E, B F, of the same length as A B, and making with A B produced angles of 45° ; bisect the angles formed at A and B, and their intersection at S will be the centre of the circumscribing circle. With S A or S B as radius, describe this circle, step A B round it from E to F in the points 1, 2, 3, 4; join E 1, 2, 3, 4 F, and the required octagon is constructed. To inscribe an octagon in a given circle: Draw two radii (Fig. 69) at an angle of 45° to each other, and they will cut the circle in points A and B ; join A B, and it will be a side of the octagon. Its length stept round the circle will give the same points as in the previous construction ; join them, and an octagon will be inscribed in the given circle.

The same principle of construction as used in the last three problems is applicable to any regular polygon, whatever may be the number of its sides ; but in practice it is preferable to subdivide the sides of those we have given—if the division will give the required number of sides—than to lay down an independent construction, the chances of *not* obtaining the exact length of the side of the polygon required increasing as the number of sides increase. On paper, and with the assistance of tee and set squares, many of the figures already given can, of course, be easily and quickly constructed ; but, as before observed, the ability to draw them *without* such aids is absolutely essential, when we consider the calls often made upon the workman for the practical application of such knowledge.

As figures, or solids, having more than eight sides or plane surfaces are seldom met with in mechanical construction, and as those we have given include all that form the surfaces of the plane solids intended to be used as objects for projection, we shall now proceed to show how their projections are obtained.

(To be continued.)



DESIGN, ETC., OF STATIONARY ENGINES.—FIG. 226.

TABLE XXXII.—DIMENSIONS OF CRANK SHAFT BEARINGS.

Diam. of Shaft.	A	B	C	D	E	F	G	H	I	J	K	L	M	O	P	Q	R	S	T	U	V	Number of Grooves.
4 3/4	9 1/2	2 15/16	1 5/16	1 1/16	7/8	1	1 3/4	2 9/16	3/4	1 3/4	[illegible]	[illegible]	[illegible]	1 3/16	1 3/8	1 3/16	25/32	2 9/16	1 3/8	1	1 9/16	3
5	10	3 1/8	1 7/16	1 1/16	7/8	1 1/16	1 31/32	2 3/4	3/4	1 3/4	[illegible]	[illegible]	1 1/32	1 3/8	1 3/8	1 3/16	7/8	2 3/4	1 9/16	1 3/16	1 3/4	3
5 1/2	11	3 5/16	1 1/2	1 3/16	15/16	1 1/8	1 31/32	2 15/16	3/4	1 31/32	[illegible]	[illegible]	[illegible]	1 3/8	1 9/16	1 3/8	7/8	2 15/16	1 9/16	1 3/16	1 3/4	3
6	12	3 1/2	1 9/16	1 3/16	15/16	1 1/4	2 5/32	3 5/32	7/8	1 31/32	[illegible]	[illegible]	1 3/16	1 1/2	1 9/16	1 3/8	15/16	3 5/32	1 25/32	1 3/16	1 31/32	3
6 1/4	12 1/2	3 3/4	1 11/16	1 1/4	1	1 3/8	2 3/8	3 11/32	7/8	1 31/32	[illegible]	[illegible]	1 1/4	1 21/32	1 9/16	1 3/8	31/32	3 5/32	1 25/32	1 3/16	1 31/32	4
6 3/4	13 1/2	3 15/16	1 3/4	1 5/16	1	1 3/8	2 3/8	3 11/32	1	2 5/32	[illegible]	[illegible]	1 11/32	[illegible]	1 3/4	1 9/16	1 1/32	3 11/32	1 31/32	1 3/16	2 5/32	4
7	14	4 5/16	1 13/16	1 7/16	1 1/16	1 9/16	2 9/16	3 15/16	1	2 5/32	[illegible]	[illegible]	1 13/32	[illegible]	1 3/4	1 9/16	1 3/32	3 9/16	1 31/32	1 3/8	2 5/32	4
7 1/2	15	4 1/2	1 7/8	1 1/2	1 1/16	1 9/16	2 9/16	3 15/16	1	2 5/32	[illegible]	[illegible]	1 15/32	[illegible]	1 3/4	1 9/16	1 3/32	3 3/4	2 5/32	1 3/8	2 3/8	4
8	16	4 3/4	1 15/16	1 9/16	1 1/8	1 3/4	2 15/16	4 [illegible]	1 1/8	2 3/8	[illegible]	[illegible]	1 9/16	2 5/32	1 31/32	1 3/4	1 3/16	3 15/16	2 5/32	1 9/16	2 3/8	4
8 1/4	16 1/2	4 15/16	2	1 5/8	1 3/16	1 3/4	2 15/16	4 [illegible]	1 1/8	2 3/8	[illegible]	[illegible]	1 21/32	2 5/32	1 31/32	1 3/4	1 3/16	4 1/8	2 3/8	1 9/16	2 9/16	4
8 1/2	17	5 1/8	2 1/8	1 3/4	1 1/4	1 3/4	2 15/16	4 [illegible]	1 1/8	2 9/16	[illegible]	[illegible]	1 3/4	2 5/16	2 5/32	1 31/32	1 1/4	4 11/32	2 3/8	1 9/16	2 9/16	4
9	18	5 1/2	2 3/16	1 3/4	1 1/4	1 15/16	3 5/32	4 [illegible]	1 1/4	2 9/16	[illegible]	[illegible]	1 13/16	2 3/8	2 5/32	1 31/32	1 1/4	4 17/32	2 9/16	1 9/16	2 3/4	4
9 1/2	19	5 3/4	2 1/4	1 13/16	1 5/16	1 15/16	3 9/32	4 [illegible]	1 1/4	2 3/4	[illegible]	[illegible]	1 7/8	2 3/8	2 3/8	2 5/32	1 5/16	4 3/4	2 9/16	1 9/16	2 3/4	4
10	20	5 15/16	2 3/8	1 7/8	1 5/16	2 3/16	3 11/32	5 1/2	1 1/4	2 3/4	[illegible]	[illegible]	1 31/32	2 9/16	2 3/8	2 5/16	1 3/8	4 15/16	2 3/4	1 3/4	2 15/16	5
10 1/4	20 1/2	6 1/8	2 3/8	1 15/16	1 3/8	2 3/16	3 11/32	5 1/2	1 1/4	2 3/4	[illegible]	[illegible]	2 1/16	2 9/16	2 3/8	2 5/16	1 3/8	5 1/8	2 3/4	1 3/4	2 15/16	5
10 1/2	21	6 1/4	2 3/8	2 1/16	1 7/16	2 5/16	3 11/32	5 1/2	1 3/8	2 15/16	[illegible]	[illegible]	2 1/8	2 9/16	2 9/16	2 3/8	1 7/16	5 1/5	2 31/32	1 3/4	3 5/32	5
11	22	6 11/16	2 1/2	2 1/8	1 1/2	2 3/8	3 3/4	5 7/8	1 3/8	2 15/16	[illegible]	[illegible]	2 3/16	2 3/4	2 9/16	2 3/8	1 9/16	5 1/2	2 31/32	1 3/4	3 5/32	5
11 1/2	23	6 7/8	2 5/8	2 3/16	1 1/2	2 3/8	3 3/4	5 7/8	1 3/8	3 5/32	[illegible]	[illegible]	2 9/32	2 3/4	2 3/4	2 9/16	1 9/16	5 1/2	3 5/32	1 3/4	3 11/32	5
11 3/4	23 1/2	7	2 3/4	2 3/8	1 9/16	2 9/16	3 15/16	6 1/2	1 1/2	3 5/32	[illegible]	[illegible]	2 3/8	3 5/32	2 3/4	2 9/16	1 9/16	5 11/16	3 5/32	1 31/32	3 11/32	5
12 1/4	24 1/2	7 1/4	2 3/4	2 3/8	1 9/16	2 9/16	3 15/16	6 1/2	1 1/2	3 11/32	[illegible]	[illegible]	2 9/16	3 5/32	2 3/4	2 3/4	1 9/16	5 29/32	3 11/32	1 31/32	3 9/16	5
12 1/2	25	7 1/2	2 3/4	2 3/8	1 5/8	2 5/8	3 15/16	6 1/2	1 1/2	3 11/32	[illegible]	[illegible]	2 3/4	3 [illegible]	2 15/16	2 3/4	1 25/32	6 3/32	3 11/32	1 31/32	3 9/16	5
13 3/8	26 3/4	8	2 15/16	2 9/16	1 3/4	2 3/4	4 5/16	6 7/8	1 5/8	3 9/16	[illegible]	[illegible]	2 5/32	3 11/32	3 5/32	2 15/16	1 25/32	6 1/2	3 9/16	1 31/32	3 3/4	5
14	28	8 1/2	3 1/8	2 9/16	1 13/16	2 15/16	4 1/2	7 1/4	1 5/8	3 9/16	[illegible]	[illegible]	2 5/32	3 9/16	3 5/32	2 15/16	1 27/32	6 7/8	3 3/4	2 5/32	3 15/16	6
15	30	9	3 3/8	2 3/4	1 7/8	3 3/8	4 23/32	7 5/8	1 3/4	3 3/4	[illegible]	[illegible]	2 3/16	3 3/4	3 11/32	3 5/32	1 29/32	7 1/4	3 15/16	2 3/8	4 1/8	6
15 3/4	31 1/2	9 1/2	3 3/8	2 3/4	2	3 3/8	4 23/32	7 7/8	1 7/8	3 15/16	[illegible]	[illegible]	2 3/8	3 3/4	3 9/16	3 11/32	2 1/32	7 11/16	4 1/8	2 3/8	4 11/32	6
16 1/2	33	9 7/8	3 1/2	2 15/16	2 1/16	3 11/32	5 1/8	8 1/4	1 7/8	4 1/8	1 1/32	[illegible]	2 9/16	3 15/16	3 3/4	3 9/16	2 3/32	7 7/8	4 11/32	2 9/16	4 17/32	6
17 1/4	34 1/2	10 7/16	3 3/4	3 5/32	2 1/8	3 9/16	5 5/16	8 7/8	2	4 5/16	1 1/16	[illegible]	2 9/16	4 11/32	3 15/16	3 3/4	2 3/16	8 1/4	4 21/32	2 9/16	4 3/4	6
18	36	10 13/16	3 15/16	3 11/32	2 1/8	3 3/4	5 11/16	9 7/16	2	4 5/16	1 1/8	[illegible]	2 3/4	4 1/2	3 15/16	3 3/4	2 3/16	8 11/32	4 3/4	2 9/16	4 15/16	6

The Design and Construction of Stationary Engines.—LIII.

Proportions of Bearings.—The length of the bearing is usually made twice the diameter. If D = diameter in inches, L = length in inches, P = load on bearing, then L = 2 D. p = the surface pressure allowable, which may be taken at not more than 168lb. per square inch. The diameter found for D on this basis has to be checked with the value required for strength. The load on the set screws should not exceed 6000lb. per square inch at the bottom of the thread. The depth of the thread is a = 0·05 G + 0·039in. This gives a diameter for the bolt F = 1·1 G + $\frac{3}{16}$in. The depth of the nuts = 1·2 F, and the diameter = 1·4 F + $\frac{1}{8}$in. The depth of boss U = 0·6 F + $\frac{3}{8}$in., and its diameter H = 2·5 F. The thickness of white metal K = 0·05 D + $\frac{1}{16}$in. The depth of the dovetail grooves L = 0·02 D + $\frac{1}{8}$in., and the width = 2 K. The numbe of grooves is equal to 0·01 D + 2. The thickness of the top and bottom cast-iron

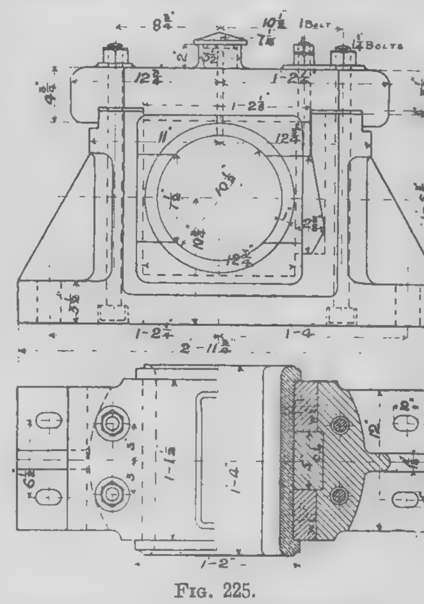


FIG. 225.

shells D = 0·17 D + $\frac{5}{32}$in., and for the sides C = 0·185 D + $\frac{1}{32}$in. The thickness of the packing plate X is obtained by observing the directions already given. The depth of the side parts should be = 0·6 D. The width of the chipping strips E = 0·02 D for bearings under 3, 14in., and = 0·015 D for bearings over 14in., and their number = 4 for diameters up to 14in., and 6 for diameters over 14in. The diameter of the lug J = 0·2 D + $\frac{3}{8}$in. The thickness of metal for cover P = 0·2 D + $\frac{3}{8}$in. Q = 0·2 D + $\frac{1}{16}$in. R = 0·125 D + $\frac{3}{16}$in. The size of the bolts for the covers I = 0·10 D + $\frac{5}{32}$in., and their number = 4. The thickness of the flanges T = 0·25 D + $\frac{1}{16}$in., and of the sides S = 0·45 D + $\frac{3}{8}$in. The thickness of the pedestal procer V = 0·25 D + $\frac{3}{8}$in.

Table XXXII. gives the dimensions for pedestals from 4$\frac{3}{4}$in. diameter to 18in.

diameter, calculated by the above proportions.

Fig. 225 illustrates another design of four-part bearing, in which provision for adjustment is made on one side only. This is effected by means of wedge-shaped bolts placed at each side of the pedestal, a cast-iron filling-up piece being placed between. The side brass, it will be seen, is adjusted by screwing up the wedge blocks. The cover is secured by four 1¼in. bolts, and the pedestal bolted to its seat by the same number of bolts of the same size.

Fig. 226 illustrates a four-part bearing much used by Lancashire makers. It is provided with two adjusting wedges at each side. The top and bottom brasses are segmental shells having flanges at the ends.

TABLE XXXIII.—DIMENSIONS OF CRANKSHAFT BEARINGS WITH FOUR-PART STEPS.

A	B	C	D	E	F	G	H	I	J	K	L	M	Thickness of Soleplate. N	O	Breadth of Sole. S	Thickness of Ribs. T	U	V	W	X	Y	Crs. of Soleplate Bolts. Z	Length of Soleplate. a	Diar. of Soleplate Bolts. b	c	d	e	f	g	h	i	j	k	l	m	n
5½	8	5¾	¾	½	2¾	7	5	¾	1⅛	2	1⅛	1¾	2	1½	7½	¾	3½	one in. cr.	6¾	6½	1⅞	10¾	28	1½	3¼	3½	8¼	1¾	¾	1¼	2	5½	4	⅞	1¼	⅛
6	9	6½	¾	½	3	7½	5½	⅞	1⅛	2	1⅛	2	2¼	2	8½	⅞	4	one in. cr.	7½	7⅛	2	12	30	1⅝	3½	3¾	9¼	1⅞	⅞	1¼	2½	6	4¼	1	1¼	⅛
6½	10	7	⅞	⅝	3¼	8	6	1	1¼	2⅛	1¼	2½	2½	2	9¼	1	4½	one in. cr.	8¼	7⅞	2¼	12¾	33	1¾	4	4¼	10	2	1	1½	3	6½	4½	1¼	1⅜	¼
7	11	8	⅞	⅝	3½	8¾	6¼	1⅛	1¾	2 1/16	1⅛	3	2¾	2¼	10¼	1	4¾	5	9¼	8⅞	3	14½	37	1⅞	4¾	4¾	10¾	2⅛	1¼	1¾	3½	6¾	5	1½	1½	¼
7½	13	8¼	1	¾	4	9½	6⅝	1¼	1½	2¼	1¼	3	3	2¼	12	1⅛	5	5½	11⅛	10¾	3	16	40	2	5	5	11⅛	2¼	1½	2	4	7	5½	1¾	1¾	¼
8	14	9½	1	¾	4	9¾	6⅞	1¼	1½	2½	1⅜	3¼	3	2¼	13	1⅛	6	6	12⅓	11¾	3¼	16	40	2¼	5¼	5¼	11¾	2¼	1¼	2	3½	7	5¾	2¾	1¾	⅜
9	14	9¾	1	¾	4½	9¾	6¾	1¼	1½	2¼	1⅜	3½	3	2½	13	1¼	5⅝	6	12⅛	11¾	3½	16	42	2¼	5½	5½	11¾	2¼	1¼	2	4	7¾	6¼	3½	1⅛	⅜
10	18	10½	1	¾	5	10¾	8	1⅜	1½	2½	1½	3¾	3¼	2½	17	1¼	8¼	8¼	16	15½	3¾	18	45	2½	6	6	12⅞	2½	1⅜	2¼	5	9	6⅞	2¼	2½	⅜
11	20	11	1⅛	⅞	5½	12	9	1⅜	1½	2⅝	1½	4	3	2¾	18	1⅜	8¾	8¾	17½	16½	3¾	18	48½	2½	6⅞	6⅞	13¾	2½	1⅜	2¼	6	10	7¾	2¾	2	⅜
12	20	12	1⅛	⅞	6	12½	9	1⅜	1½	2⅝	1½	4	3¼	2¾	18	1⅜	8¾	8¾	17½	16½	4	19	49	2½	6⅞	7⅛	14½	2½	1⅜	2¼	6	10	8	2½	2	⅜
13	20	13	1⅛	⅞	6½	13 1/16	9 3/16	1⅜	1½	2½	1½	4	3½	3	18	1⅜	8¾	8¾	17½	16½	4	20¼	49½	2½	6⅞	7¼	15 5/16	2½	1⅜	2¼	6	10	8	2½	2	⅜
14	26	14	1¼	1	7	13¾	10½	1½	1⅝	2⅞	1⅝	4	3½	3	24	1½	10¾	12	23½	22½	4½	22	55	2⅝	7½	8	16⅛	3	1½	2¼	7	10¾	9¾	2¾	2	⅜
15	28	15	1¼	1	7½	14¾	11¼	1½	1⅝	3⅛	1⅝	4	3¾	3½	25	1½	12¾	14	23½	24½	4¾	23½	60	2¾	9	9	16⅞	3¼	1½	2¼	9⅞	11½	10	3	2	¼
16	30	16	1 5/16	1	8	15¾	12½	1½	1¾	3¼	1¾	5	4	4	27	1½	15	16	24	26	5	25	65	3	9½	9½	18	3½	1½	2¼	10¾	12¼	10⅝	3	2	¼

The bottom brass has a stop piece *l* cast on to prevent it from turning round. This form of pedestal allows of the brasses being withdrawn without having to remove the shaft.

Table XXXIII. gives the main dimensions for a number of bearings of this type, which will be found useful.

Some engine builders arrange for the side steps to be adjusted horizontally instead of vertically. The wedge blocks are in two parts, the thick end being to the outside and the thin end to the inside, the backs of the side brasses being formed to suit. A bolt having a right and left-hand screw cut on it passes through the blocks, and by turning this screw in either direction the wedge blocks are moved outwards or inwards as desired, pressing the brasses closer together in the latter case, and so taking up the wear. This is a very neat and substantial arrangement, though not widely adopted. There are many other arrangements which we have not referred to, but they are more remarkable for their oddity than their merits, and the forms we have illustrated represent the more serviceable ones in common use. In shafts having sunk journals it is important to have the corners rounded to as large a radius as possible, and the brasses formed to suit. It is much better practice to have the necks plain cylinders without shoulders, the crank boss forming the collar on the one side and the eccentric or some other fixing serving to prevent end-play on the other side. Turning the necks down out of the solid is often a cause of the failure of crankshafts.

In bearings for heavy shafts having four-part steps, it is a good plan to chamfer or round off the edges of the steps at the partings, as shown in Fig. 221, as it greatly assists in securing good lubrication. The spaces at these points help to hold the oil better, and it is important to see to this being properly done, even in small two-part bearings. Some makers, to effect the same purpose, have the brasses bored out a slightly larger diameter than the shaft neck, afterwards machining sufficient off the edges where the brasses come together to allow of the bearing fitting on four places only, leaving a space at the junctions into which the oil will find its way. The amount the brasses are bored larger than the shaft is from $\frac{1}{64}$ to $\frac{1}{100}$in. per inch in diameter.

(*To be continued.*)

The Russian Minister of Communication has asked for a vote of 1,000,000 roubles to defray the expense of constructing a large basin at St. Petersburg capable of holding thirty steamers and a number of lighters. It has been found necessary to take this step in consequence of the increase of the Russian Navy, and the insufficient dock accommodation in Cronstadt for ships of war.

Some Applications of Electricity to Chemistry.

On the 15th inst., at the Royal Institution, Mr. James Swinburne began a course of three lectures on the various applications of electricity to chemistry. Now that dynamo-electric machines, said the lecturer, are made which give high efficiencies, and which are low in cost, and the applications of electricity to commercial chemistry are increasing, we may truly say, every week, the future development of electro-chemical work will be so enormous that even a bird's-eye view of the subject ought to be interesting. Most of the applications depend on the electrical decomposition of saline solutions or electrolytes. When electricity is passed through an electrolyte it is split up into two components, of which one is higher and the other in a lower state of oxidation. In the simple case of passing electricity through water, oxygen is produced at one pole and hydrogen at the other. Again: If, for instance, chloride of copper is electrolysed, chlorine comes off at one pole and copper at the other. As the terms oxidation and reduction are already so extensively, though loosely, used, and as they apply also to chemical actions performed on bodies which are not electrolytes, it will be better to adhere to those used. The work of a chemist consists very largely in oxidising or reducing the various substances with which he deals. Sometimes, also, he is making changes or substitutions. Here, then, electricity will be of great aid to him. The advantage of the electrical over the chemical method is very great. To reduce water to hydrogen, it would have to be heated in contact with iron, carbon, or something which has enough affinity for oxygen to abstract it from the water. In this case the hydrogen is set free, but the oxygen is not. By electrolysis, however, the oxygen or hydrogen, or the copper and chlorine, are produced direct without any complications and without introducing foreign substances. Electricity has a magnificent future in metallurgy. The important alkali industry consists of splitting up common salt into caustic soda and chlorine, and the process of manufacture as at present carried on is a bewildering maze of oxidation, reduction, and substitution. In making alkali and bleaching powder by the Leblanc-Welder process there are four oxidations, one reduction, and three substitution processes. By electrolysis, salt is decomposed into caustic soda and chlorine at one operation without the aid of any other chemicals, and without any waste or loss. It is probable that sodium and potassium will soon be produced from their fused salts in the same way. The oldest application of electricity is electroplating. The process of electroplating with silver, gold, and nickel, is so well known that it will be better not to devote the short time at my disposal to their consideration, except mentioning a few recent developments. Electroplating with silver containing a small percentage of cadmium was a recent improvement. The sulphide of cadmium was yellow, and combining as it does with sulphur more readily than silver, it is said to absorb the sulphur, and to form a thin coating of cadmium sulphide, which protects the silver so that it is not blackened by fumes of sulphuretted hydrogen. It must be remembered that it was by electrical means that sodium, potassium, magnesium, lithium, barium, and calcium were first produced. All these metals, with one exception, were first isolated by Sir Humphrey Davy, Professor of Chemistry at the Royal Institution. More recently electrolysis has been used in the endeavour to isolate fluorine by electrolysing fluoride in a vessel made entirely of a fluoride. In chemical analysis electricity can be a great help. By its means metals can be separated that are troublesome to deal with by purely chemical methods. As an example of the application to analysis, testing for arsenic in forensic cases may be mentioned. One of the most complicated branches of the study of chemistry is the formation of dyestuffs. Oxidation and reduction can frequently be carried out by electrolysis without introducing special oxidising and reducing agents. Here is a wide field for scientific research. Whether such a process is valuable commercially is a matter of doubt, but it is well worthy of further attention to provide the chemist with a new method of investigation, and may lead to important discoveries in this branch of organic chemistry. Electricity also derives benefit from chemistry. Faraday discovered that the quantity of metal deposited was strictly in proportion to the quantity of electricity passed through the solution. This has provided electricians with a very exact method of measuring quantities of electricity. Lord Rayleigh had made very careful determinations of the exact weight of silver deposited by a unit quantity of electricity, and this measurement now serves as the practical standard for the measurement of electricity, and hence of electric currents.

Chains and Chain Testing.

A paper was read at the Grand Hotel, Birmingham, on Saturday evening, the 8th inst., before the Birmingham Association of Mechanical Engineers, by Mr. E. J. Taylor, of the firm of E. Baylie and Co., Stourbridge, on "Chains and Chain Testing."

After giving a short account of the earlier inventions of chains and the various conditions of their production in factories and out workshops, illustrated by means of a few photos and samples of work made in either case, Mr. Taylor went on to the larger and perhaps more interesting subject of actual results in the testing house from finished chain. There were exhibited for the inspection of members a fair selection of the highest, medium, and lowest grades of chains as at the present time put upon the market, and a tabulated statement given showing tests not only from the chains themselves, but also from the bar iron used in their manufacture, comparisons being made of all three grades. He pointed out that the usual plan of breaking only these or a very few number of links out of any length of crane chain was scarcely a first-class and not really an approximate means of ascertaining quality, or perhaps even the strength of a chain. He also recommended all users of chains to select a yard, and carefully note its behaviour under gradual application of a breaking load. Some very instructive samples and figures were given of this method of testing and arriving at the quality of any chain.

The usual class of machines used for chain testing, the question of collapsing of rings or wide links under strain, galvanising and annealing of chains, etc., also came in for a share of attention. The question of welded steel chain was also touched upon and some results given, but Mr. Taylor evidently considered that the difficulty of making a number of consecutive welds, even by the most skilful of chainmakers, was so great that a chain little, if any, stronger than a first-class iron one could be produced, although for wearing power perhaps the steel chain might be preferable.

The association was informed in the course of the paper that for the purpose of obtaining a fair average *loss of strength* due to working iron up into chains, some fifteen years of the firm's trading had been gone through and over 2000 samples of chains tested to destruction taken out to ascertain same. A large number of figures were given, and at the end a short discussion took place, touching upon the strength of block chains, also galvanising and annealing of crane chains, and prices paid for outworkers' wages. No doubt a further discussion would have been interesting, as from the position the firm (of which Mr. Taylor was one of the managing partners) occupy in the crane-chain trade, they are no doubt in possession of facts regarding high-class chains for engineering purposes which would enable Mr. Taylor to speak with some degree of authority.

The members of the above association paid a visit, on Saturday, 15th inst., to the works of Messrs. Tansley and Haines, Fazeley-street, Birmingham, and inspected the cold stones, electric installation, and the process of ice making. A very large number of members were present, and Mr. Haines, who is a member of the association, took the party round and explained in detail the making of ice, which was of a very interesting if not of an agreeable character, in consequence of the strong smell of the ammonia. The party afterwards visited Messrs. Fellows, Morton and Clayton, canal carriers, who, among other things, build their own engines, boilers, etc., for their boats. Altogether the visit was of a very interesting and instructive nature, and at its conclusion a cordial vote of thanks was, upon the motion of Mr. J. Floyd, awarded to Mr. Haines for his kindness and courtesy during the visit, which was suitably acknowledged by Mr. Haines.

Shipbuilding Notes.

On the 20th inst., there was launched from the shipbuilding yard of Messrs. Scott and Sons, Bowling, a screw steamer, 108ft. 6in. by 20ft. by 9ft. 6in. The engines, which are compound surface-condensing, are being supplied by Messrs. Ross and Duncan, Govan.

On the 22nd inst., H.M.S. "Niger," the third of the six torpedo gunboats built by contract under the Naval Defence Act of 1888, took her trial in Morecambe Bay, and this proving satisfactory the vessel was handed over to the navigating party appointed to receive her, and taken to Sheerness.

The steel screw steamer "Iris" left Palmer's shipyard, Jarrow, on the 20th inst., on her trial trip. The vessel is of the spar-deck type, and is specially adapted for the carrying of oil and general cargoes. The speed attained during trial was 11½ knots, which is above the guaranteed speed.

On the 18th inst., at Stockton, Messrs. Ropner and Son launched a steel screw steamer of the following dimensions:—Length, over all, 333ft.; breadth, 41ft. 6in.; depth, moulded, 24ft. Triple-expansion engines of 1100I.H.P. will be supplied by Messrs. Blair and Co. Limited, with two large steel boilers working at 160lb. pressure.

On the 18th inst. the s.s. "Maggie Barr," built by Messrs. Murdoch and Murray, Port-Glasgow, and engined by Messrs. Muir and Houston, Glasgow, went on her trial trip. The vessel is of the following dimensions, viz:—142ft. by 23ft. 6in. by 10ft., with compound surface-condensing engines, having cylinders 20in. and 40in. diameter by 27in. stroke. A speed of 12 knots was attained on the measured mile.

Messrs. Mackie and Thomson, Govan, launched, on the 19th inst., two small steel screw steamers, one a tug and the other a trawler. Both are about 140 tons gross. The tug is 95ft. long, 20ft. 8in. broad, and 11ft. 6in. deep; and the steam trawler, 101ft. long, 20ft. 6in. broad, and 11ft. deep. Messrs. Dunsmuir and Jackson supply the engines for the tug, and Messrs. Muir and Houston those for the steam trawler.

The Naval Construction and Armaments Company launched from their yard at Barrow, on the 18th inst., the troopship "Warren Hastings," which has been built for the Secretary of State for India. The vessel is 350ft. long, 49ft. wide at her beam, and 36ft. 9in. in depth. She is fitted with twin screws, and is subdivided into 33 water-tight compartments, rendering her practically unsinkable. Electric lighting is fitted throughout the vessel. She will be armed with six quick-firing guns, six three-pounder, and four five-barrelled Nordenfeldt guns. She is fitted with two sets of triple-expansion engines, and will steam about 16 knots.

On Machine Designing.

[CONTRIBUTED.]

(*Continued from page 132.*)

(3.) SUITABILITY OF MATERIAL.—Every material employed by the engineer has some characteristic property, or properties, that makes it most suitable for any particular application. Some of these qualities are:—Tenacity, stiffness, ductility, ease of shaping, capacity of welding, cheapness, flexibility, hardness, softness, elasticity, lightness, non-corrosibility and conductivity; any one of which may be of primary importance, according to circumstances.

Cast iron is very largely employed as a material of construction, especially in the cheaper kinds of machinery, for it is comparatively cheap, can be readily cast, when liquid, into any desired form, can easily be machined, chipped, filed, and scraped; and, at the same time, is fairly strong and very rigid. These qualities make it especially useful for machine-tool construction, where weight is no great objection, and there are so many plane surfaces to be scraped to a bearing. It is also largely used for wheel gearing, owing to the faithfulness with which it takes the mould, and for pillars because of its great compressive strength. The material also admits of being readily ground and glazed, for appearance' sake, to a high polish—another advantage.

Cast steel is a material also now used to a considerable extent, because it possesses, in almost equal measure, the same good qualities as cast iron, and, in addition, it is much stronger. Hence castings of it may be made lighter. It has the disadvantages, however, of being more expensive, less easily tooled, and of containing usually a much larger number of blowholes than iron castings. The latter defect is very objectionable where a finish is desired. For many details—as brackets, beams, and heavy gearing in connection with naval engines and the gun-working machinery of battleships, where lightness is important,—cast steel has entirely supplanted cast iron. It is also used for the wheels of locomotives.

Crucible cast steel, otherwise known as tool steel, and high steel, which possesses the characteristic property of hardening when plunged into water or other liquid, is used for parts of machinery that require to be made very hard—as, for example, knife-edges, the tailpins of lathes, thrust washers, punches and dies, shear blades, and cutting tools generally. Springs are made from steel bars which have been prepared by the processes of cementation, and subsequently rolled; but the material has not been cast into ingots, and contains a smaller percentage of carbon than tool steel. Springs require to be hardened and tempered before use to obtain the necessary elasticity.

Malleable cast iron is employed to a considerable extent for the small, intricate, and delicate castings of textile machinery. It is also suitable for small pinions. The castings are first produced in the ordinary way, when they are too brittle for use. To "soften" them, they are packed in cast-iron boxes, being completely surrounded either with the iron ore known as red hematite (ferric oxide) or with ordinary smithy scales—the magnetic oxide of iron. The whole is then raised to red heat, and after one, two or three days—according to the size of the castings—allowed slowly to cool. At the high temperature at which the operation is conducted, a chemical action takes place between the cast iron and the ore, the oxygen uniting with the carbon to form carbon-dioxide gas, which passes off. This elimination of the carbon results in the exterior becoming converted into a soft, tough material, somewhat resembling wrought iron, which is easily machined, and will stand shocks much better than cast iron. It cannot, however, be welded.

Gun-metal, or bronze, an alloy of copper and tin in the proportion of about 9 to 1, is very largely used for cylinders, valves, and pipe connections of hydraulic machinery, because it withstands the corrosive action of water, can be cast and worked with great facility, possesses considerable tenacity, and presents a good appearance. It is also a very useful material for small gearing, and for the bearings of rotating pieces.

Manganese bronze, which contains a little of the element of manganese, is about twice as strong as ordinary bronze—in fact, almost equal in tenacity to steel,—and is being increasingly used for important castings, including hydraulic cylinders and stop valves, worm wheels and gearing generally when lightness is specially desired. It is, however, considerably more expensive, and less easily cast, than gun metal.

Brass is a cheaper alloy than gun metal, and is not so strong and tough. It consists of about 6½ parts of copper to 3½ of zinc, or nearly 2 to 1, but the composition varies considerably. Its appearance differs little from that of gun metal. It is not employed for high-class hydraulic work, but very largely for steam fittings, and for bearings when cheapness is aimed at.

For forgings, *mild steel* is now almost exclusively used in the best class of work for shafts, cranks, levers, rods, pins, bolts, and a host of other details. It is the strongest and best material available for general work.

Wrought iron is now seldom employed, except for very awkward forgings, stamped work, and the field-magnet cores of dynamos, where steel does not answer so well. It is less strong, not so clean, and will not take so high a finish as mild steel, and is very little cheaper. Wrought iron is often casehardened, a process which converts the exterior into steel.

Rolled manganese bronze bars, also forgings, can now be obtained, and are excellent where strength, combined with immunity from the corrosive action of water, is important. This material is extensively used in the best class of hydraulic work for valve spindles.

Other materials employed by the engineer are:—*Muntz metal*, a variety of brass, for the pins of working joints; *phosphor bronze*, for heavy bearings; *copper*, for steam and hydraulic pipes and bends for locomotive fireboxes, on account of its high conductivity, and for special bolts, owing to its freedom from corrosion. Also *manganese bronze* and *steel* for high-pressure hydraulic pipes; steel and brass tubes for boilers; aluminium bronze for fine graduated strips; leather for belts; leather, indiarubber, gutta-percha, hemp, and asbestos for packings; indiarubber blocks or cylinders for locomotive buffers; and finally *wood*, for obvious uses.

Structures are built up of rolled plates, bars, angle bars, and rivets, all of which are now usually of steel.

(4.) CONVENIENCE OF ARRANGEMENT.—Whether in the disposition of the component parts of a simple tool or machine, or in the organisation of an elaborate and complex plant of machinery, it is of the utmost importance that every detail be suitably located. It is not without much careful thought and judgment, combined with an intimate knowledge of the conditions of operation, that the propelling engines of a large steamship, the hydraulic machinery of a modern battleship, or the engines, shafting, and machines of an extensive electric-lighting station, can be most effectively arranged. Some of the conditions that demand attention in such cases are:—

(*a*) *Regard for the Convenience and Safety of the Men in Charge.*—This means a reasonably roomy place in which to work; sufficient light and ventilation; a suitable disposition of footplates, gratings, and handrails; the provision of guards or fencings to protect from belts, gearing, and moving parts generally; shields to prevent oil and water being thrown about. Also, sufficient headroom; doorways, manholes and handholes fairly large; ladders that can be ascended and descended with safety; and passages reasonably free from obstruction.

It is not difficult to make the men fairly comfortable in the case of stationary installations on land, where space is tolerably cheap; but at sea, and on moving machinery generally, the difficulty is greatly increased. Especially is this the case on board warships, where the machinery must, for safety, be kept as far as practicable below the water line, and be further encased within a thick protective deck. The hydraulic machinery also of battleships is completely clad in armour of immense thickness. Nevertheless, men have to attend to engines, boilers, guns, and machinery, often, it must be admitted, in far from ideal surroundings as to comfort.

(*b*) *Convenience of Manipulation.*—This implies in machine tools, for example, such a height and position of the work as will admit of easy handling, access, and inspection; a suitable height of handles, handwheels, and other adjusting devices; a convenient position of the strap-shifting gear, as well as any clutch levers that may exist, and other similar requirements.

In hydraulic work there should be ample room about all hand levers, working valves, stop valves, and other details requiring handling. The pipes should be so led off as to be as far as possible out of the way, and yet the joints easy to get at. Glands that occasionally require repacking should also be readily accessible, so that they may be tightened up as occasion demands; and provision should be made for getting out pistons and other internal moving parts.

When there exists a number of handles commanding a series of operations, they should be placed near together, so that no time and energy may be lost in running from one to another. Each handle and handwheel should be provided with a suitable direction or instruction plate, so as to avoid confusion as to its precise function and direction of motion.

(*c*) *Duplication of Parts.*—Under certain circumstances, a complete breakdown of machinery would be calamitous. Hence it is the practice in, for example, electric-light installations, in the propelling machinery of warships, in the hydraulic-pumping engines, the turret-turning engines, and the machinery generally of battleships, to provide two sets, so that if one set breaks down, the other is still available. In the last named, auxiliary engines are also supplied to work the machinery at a diminished speed in the event of the failure of the main engines. As a last resource, hand gear is also fitted, so that when hydraulic engines fail, a gang of men may still continue the work.

(5.) A SUITABLE NATURE AND AREA OF BEARING SURFACE TO PREVENT HEATING AND UNDUE WEAR.—This condition is especially important in the case of high-speed machinery. Knowing by experiment and from practice what maximum pressure per unit of area may be safely permitted for each kind of material and speed of movement, the necessary area to sustain a given force may easily be determined by a simple arithmetical operation.

The materials commonly employed for bearings are:—Cast iron in light cheap machinery—looms, for instance; brass, gun metal, white metal, phosphor bronze, and lignum vitæ (wood) for the stern tubes of steamships. Various patent anti-friction alloys of the class known as Babbitt metal are also in use for heavy bearings. These consist of various mixtures of tin, lead, antimony, and copper. They are not used alone, but, being fusible at a low temperature, are run into recesses prepared for them in the main step of gun metal, which prevents the soft alloy spreading under the pressure. These acquire during use a smooth, polished surface, producing little friction.

(*To be continued.*)

Society of Engineers.

THE next ordinary meeting of this society will be held at the Town Hall, Westminster, on Monday, the 1st May, when a paper will be read on "Blake's Bridge, Reading," by Mr. Edmund Burrows, of which the following is a synopsis:—Location; description of old bridge; reasons for reconstruction; description of new bridge; comparison between girder and arch form of construction; transmission of strains in lattice girders; use and tests of mild steel; application of cast-iron ornament for completing parapet; pile foundations and method of calculation; method of erection; mode of testing for deflection; strains and stresses; cost.

Catalogues, Price Lists, Etc.

Engineers, Tool Makers, Metal Merchants and others are invited to forward Catalogues, Pamphlets, Circulars, Price Lists, etc., for notice in this column.

FROM the NOTTINGHAM CHEMICAL COMPANY, Goldsmith-place, Nottingham, we have received a circular setting forth the advantages of soda tannate as an incrustation preventive for steam boilers. The makers treat the question of incrustation from a scientific standpoint, and undertake the analysis of the water without cost to purchasers. We have repeatedly pointed out that only in this way can a satisfactory scale solvent be determined. The soda tannate is supplied either in a liquid or a crystal form, while a special compound for waters containing sulphate of lime and all hard waters, called Liberacrustos, is also obtainable from this firm. The makers claim that no injury to the plates is caused by the use of either of these scale preventers, and as the impurities are deposited in the form of mud, they can be blown off daily if desired.

From Messrs. MELDRUM BROS., City-road, Manchester, we have received a very neat pamphlet, in which the "Meldrum" furnace is described and illustrated. By the use of this apparatus an economy of upwards of 50 per cent. in the cost of fuel is claimed to have been effected in a number of cases, when low-class fuels are available. From the testimonials appended it is clear that the device is in highly successful operation in a very large number of boiler furnaces.

Messrs. THOMAS SHORE AND SONS, Albion Foundry, Shelton, Hanley, have issued an exceptionally neat leaflet descriptive of Shore and Coupe's patent feed-water heater. The makers claim that, worked with exhaust steam, this heater will effect a saving of from 10 to 14 per cent. in fuel, and will probably pay for itself in the course of twelve months. The leaflet, which is illustrated, contains full dimensions of the various sizes of heaters, prices, etc.

The "Victor" turbine is very fully described and illustrated in a pamphlet recently issued by Mr. FREDERIC NELL, 16, Mark-lane, London. Illustrations are also given of various arrangements of the turbine, and also tables of power developed, instructions for fixing, etc. The book, which contains 100 pages, is well worthy of perusal by those contemplating the adoption of water-power.

Mr. F. R. PUTZ, South-parade, Manchester, has favoured us with a copy of the latest edition of the descriptive catalogue of Bell's Asbestos Company Limited, which contains full particulars and prices of the various specialities of this well-known firm. We have also to acknowledge the receipt of a very effective calendar for 1893 and 1894 from the same firm.

The FRICTIONLESS ENGINE PACKING COMPANY, Glasshouse-street, Oldham-road, Manchester, have also sent us a calendar for this year and next. It is embellished with a number of photographs of the members of the firm and its representatives.

A number of testimonials as to the merits of the "Hercules" turbine are given in a list recently issued by Mr. JOHN TURNBULL, jun., Blythswood-square, Glasgow.

Trade Notes.

Messrs. Samuda Brothers' works at Blackwall are to be offered for sale at the Mart, London, on May 1.

Messrs. C. and L. Shaw have purchased the Huyton Quarry Iron and Steel Works, and intend starting them this month.

Messrs. John Shaw and Co., Maryhill Ironworks, Glasgow, have obtained the contract for 400 tons of cast-iron pipes required by the Limerick Corporation.

The contract for the porcelain insulators for the electric-lighting system of the city of Aberdeen has been placed with Messrs. Stiff and Sons, of London.

Mr. Edward Wood, Ocean Ironworks, Manchester, has contracted to supply a large semi-circular steel roof for a hall which is to be erected at Douglas, Isle of Man.

Messrs. Brown, Marshalls and Co. Limited, Saltley, Birmingham, have just completed two large sleeping cars for the Argentine Great Western Railway Company.

Messrs. Siemens Brothers and Co., of London, have been awarded the contract for supplying and laying the electric conductors for the electric-lighting scheme at Whitehaven.

Messrs. James Dunlop and Co. have just added to their ironworks at Clyde, Tolcross, a complete plant for the recovery of tar and ammonia from the blast-furnace gases.

The Brush Electrical Engineering Company have contracted for the supply of the electric generating plant required for the electric lighting of the Gardening and Forestry Exhibition to be held at Earl's Court this year.

Mr. Thomas Yates Wilkes, proprietor of the West Bromwich Bolt and Nut Company, Sams-lane Works, has purchased the business of A. E. Bills and Co., bolt and nut manufacturers, Bright-street, West Bromwich.

Messrs. Thomas Parish and Son, nail and rivet manufacturers, Halesowen, near Birmingham, have purchased the old-established business and the stock of Mr. John Bloomer, nail, chain and rivet manufacturer, Cradley Heath.

Mr. George Wragge, Wardry Works, Salford, has just received instructions to supply the whole of the art metal work for the new staircases, balconies, etc., to be fixed at the Manchester Royal Exchange, and also for the main staircase, balustrades, gates, etc., for the Manchester new Corn Exchange.

The Scottish Tubemakers' Association, which formerly regulated the prices of tubes in Scotland, is, it is stated, about to be resuscitated. Since the collapse competition has become exceedingly keen, and there is a general feeling that if prices in the future are to be in the slightest degree remunerative, combination in some form or other is an absolute necessity.

Having regard to the enormous circulation of THE MECHANICAL WORLD, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if MECHANICAL WORLD readers will kindly bear this in mind as occasion arises.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 85, Strand, London, or New Bridge-street, Manchester.

COMPOUND MARINE ENGINES.

MESSRS. ROSS AND DUNCAN, ENGINEERS, GLASGOW.

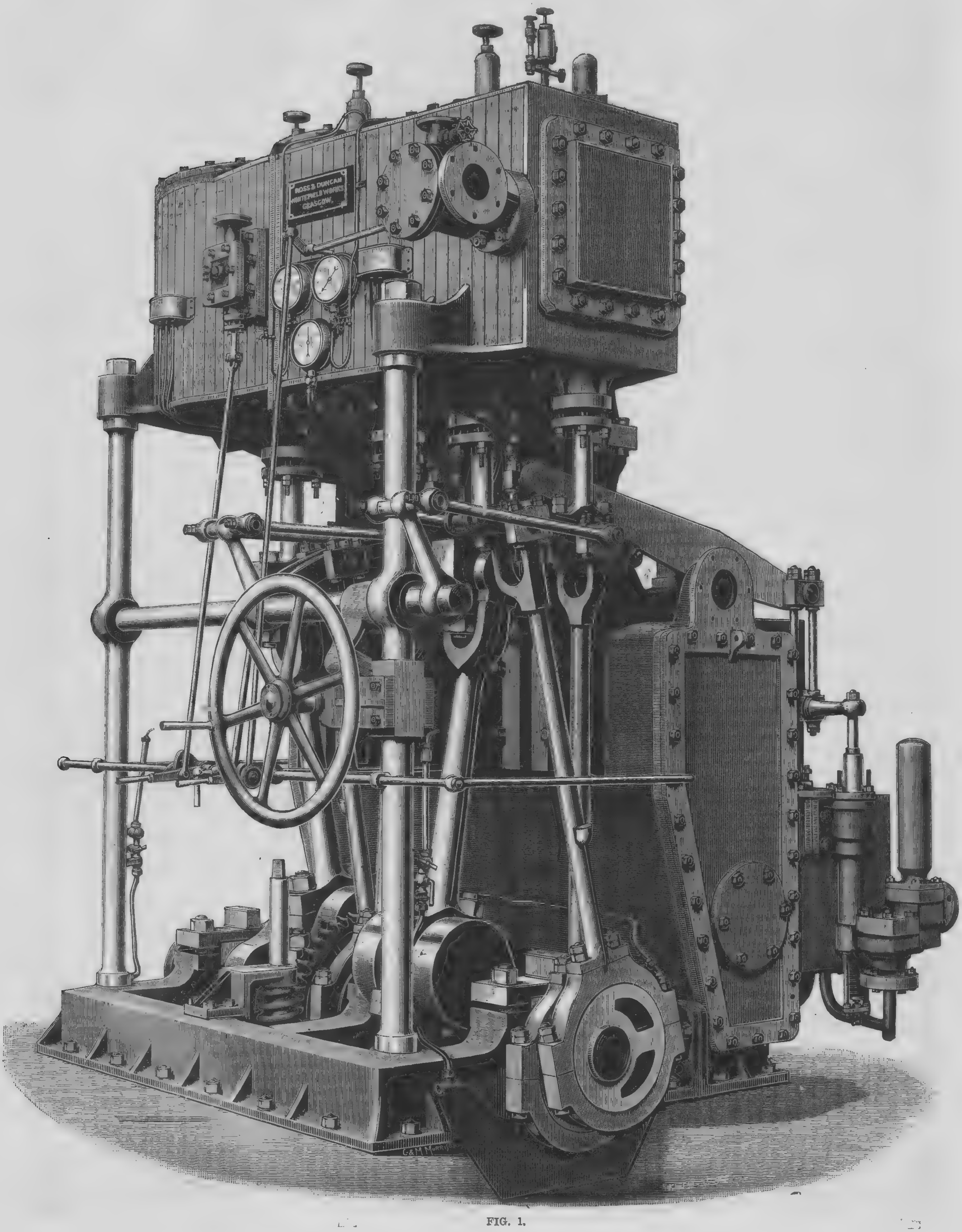


FIG. 1.

Compound Marine Engines.

HEREWITH we give illustrations of a set of compound surface-condensing marine engines constructed by Messrs. Ross and Duncan, Govan, Glasgow. A general view of the engines is given in Fig. 1; a front elevation in Fig. 2; end elevation, Fig. 3; and a plan in Fig. 4. As will be seen, the engines are of the type which, for powers up to 800I.H.P., is much favoured for coasting vessels, and one which has been found preferable to triple-expansion engines for these and for other vessels making short runs. Owners who have triple engines fitted in their vessels have in many instances reverted to these compound engines in their later boats, their reasons being that the first cost is much less than for triples of equivalent power, that there is greater ease and simplicity in handling these engines, and—what is of chief importance—that the wear and tear, especially in the case of the boilers, is much less than in triples, and the consequent cost of upkeep much lower. This latter point of wear and tear in boilers is indeed one of the chief objections to triple engines for short and numerous runs in trading from port to port along the coast, as either full pressure of steam is not got up, and consequently there is no economy of fuel over compounds, or, if the pressure is constantly being quickly got up to 160lb. and lowered again (as is necessary in short runs), the boilers very soon give serious trouble. The consumption of fuel in these compound engines at high pressures is very little more than in triples, and any difference there is is more than counterbalanced by the advantages named above. The engines illustrated have cylinders 17½in. and 35in. diameter, with a stroke of 24in., the indicated horse-power being 420, at 110lb. steam pressure, and 115 revolutions per minute.

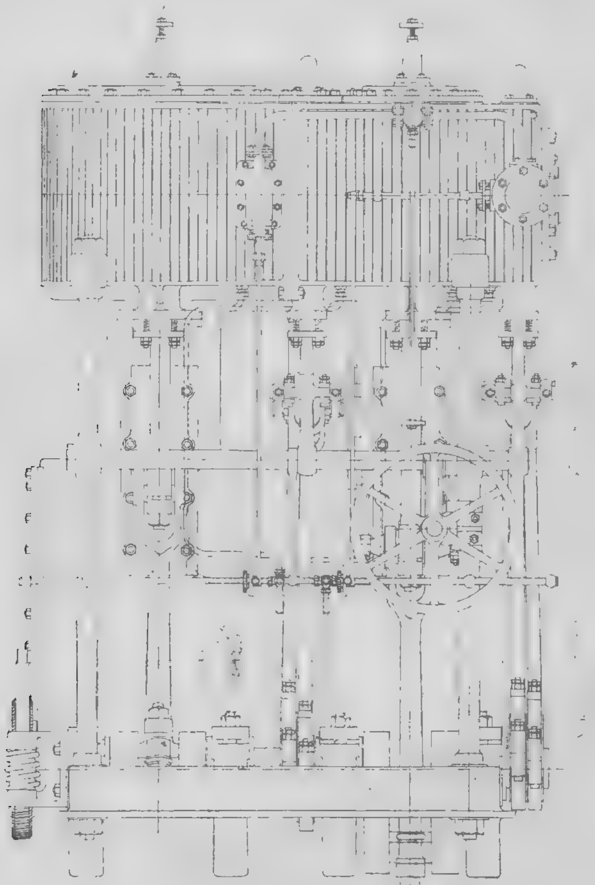
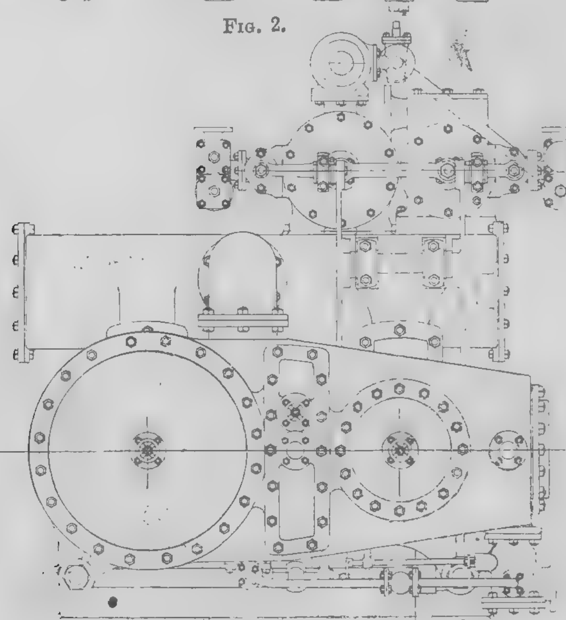


FIG. 2.

FIG. 3.



COMPOUND MARINE ENGINES.—FIG. 4.

The Cultivation of the Inventive Faculty.

A PRAISEWORTHY attempt to cultivate the inventive faculty has been made by Mr. Leicester Allen, who has from time to time set in the "American Machinist" a number of constructive problems, the solution of which has aroused considerable interest among engineers, mechanics, and students of mechanism generally. As we think that probably some of our readers would like to attempt the solution of such problems, we give herewith the latest one set by Mr. Allen:—

"In the figure two discs, A and B, are keyed to the ends of two parallel shafts fitted to turn in fixed bearings. A is required to drive B by mechanism subject to the following restrictions:—

"1. If any point, as *a*, be taken in A, at a given distance from its axis of rotation, any point, as *b*, taken in B, at the same distance from its axis of rotation, must have, at any time, the same velocity of rotation that *a* has, or, as books on mechanics would put it, the velocity ratio of these points must be 1.

"2. This is now done in coupled driving wheels of locomotives by two cranks (or their equivalents) on each shaft, the cranks being set at an angle with each other—usually a right angle—and two coupling rods, but it must be understood *that such a device is rigidly excluded in the solution of this problem.*

"3. Belts of any kind, toothed gearing, friction wheels, or sprockets are excluded.

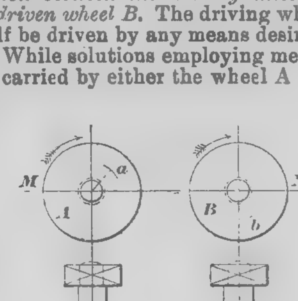
"4. The motion of the driven wheel must be continuous and in the same direction as that of the driver, so long as the driver continues to move in that direction. The direction of rotation is not required to be reversible, but if it can be made so it will be a desirable feature in such a movement.

"5. There must be no dead point in the driven wheel; when the driver starts to rotate, the driven wheel must start also, no matter what position any point in it may occupy relative to the line of centres M N.

"6. The motion desired is extremely slow—one rotation of the driven wheel in 30 minutes,—and as the wheels are only 1in. in diameter, and the distance between their centres is 1½in., the mechanism may be extremely light. However, as there may be cases wherein a stronger movement of this kind might be desirable, I will add that the problem practically admits a solution for much larger wheels and higher velocities.

"The restriction that no toothed wheels, belting of any sort, or friction wheels are allowable, relates to *the immediate connection between the driving wheel A and the driven wheel B.* The driving wheel may itself be driven by any means desired.

"While solutions employing mechanism not carried by either the wheel A or B, or



both of them, or by their shafts, will not be rejected if they do not overstep other restrictions, I will say that those solutions will be considered best that use only devices attached to and connecting the two wheels. The problem admits of a very neat solution in this way, and I hope this method will be perceived by many who will take the problem into consideration."

If any of our readers care to submit solutions (which should comprise a clear sketch or drawing, and a brief description), we will publish those which in our judgment best fulfil the conditions imposed. We may also reproduce some of the solutions sent to the "American Machinist," in order to make an interesting comparison which, we trust, will show that mechanical ingenuity is not yet altogether extinct in the old country.

The Institution of Mechanical Engineers.

THREE papers were down for reading at a general meeting of the Institution held on Thursday and Friday last, the 20th and 21st insts, under the presidency of Dr. Anderson, but the time at disposal only permitted of two being considered. The first, by Professor W. C. Roberts-Austen, C.B., F.R.S., was entitled:—

"SECOND REPORT TO THE ALLOYS RESEARCH COMMITTEE."

The object of the investigations dealt with (which form a continuation of previous work treated in the "First Report," given in the "Proceedings" of the Institution for 1891, p. 543) was to extend a research previously made by the author upon the application of the "periodic law" of Newlands and Mendeléeff to the mechanical properties of metals. As originally expressed, this law states that "the properties of the elements are a periodic function of their atomic weights." The author pointed out that it had already been shown that the effect of impurities added to gold is nearly proportional to their atomic volumes, the larger the volume of the atom the greater being its effect; and the question was, Does this hold good for other metals? It was manifest that the most important evidence which could be gained was that relating to the thermal disturbance which accompanies any molecular change; and, as this usually occurs at high temperatures, it was necessary to develop and perfect the methods which were available for measuring them, and for recording the results. The first report therefore dealt with the description of certain new methods and appliances that had been adopted in conducting the inquiry, the most important being a photographic method of pyrometry. Before describing the experiments which have been made, the author directed attention to further considerations, which seem to point to the possibility that the influence of small quantities of added elements on the mechanical properties of masses of a metal will be in proportion to the atomic volume of the impurity.

INFLUENCE OF IMPURITIES ON COPPER.

The mechanical properties of copper are known to be strangely affected by the addition of foreign matter. The results already obtained with iron at once suggest the question whether copper is a metal whose ultimate atoms are capable of arrangement in different ways in the molecule. Can normal copper be made to assume an allotropic state, analogous to that in which there is reason to believe iron can exist? If it can, are the properties of normal and of allotropic copper as widely different from each other as are those of the distinct varieties of certain well-known non-metallic elements? There seems to be little doubt, according to Schützenberger, that copper can be prepared by electrolytic deposition in an allotropic state, in which the density of the metal is from 8·0 to 8·2, as compared with 8·92, which is that of normal copper. The allotropic variety also shows a readiness to undergo chemical change, which is not shared by ordinary copper. The evolution or absorption of heat, however, during gradual cooling or heating, which is evidence of marked reversible thermal effects, and is a main indication of molecular change, is not so easy to detect in copper as it is in iron which is being gradually cooled or heated. On the other hand, it is held in the case of iron that subjecting the metal to any mechanical stress which tends to produce permanent deformation of the mass enables the iron to assume an allotropic form. In this respect the purest obtainable copper seems to be singularly sensitive, inasmuch as its subjection either to stress which deforms the metal, or to annealing, the tendency of which is to reverse the effects of mechanical stress, is accompanied by profound changes in the mechanical properties. It is impossible to say, for instance, what the standard tenacity of a normal sample of pure copper should be taken to be, as so much depends on the previous history of the piece of metal, especially as regards the mechanical and thermal treatment to which it has been subjected. The variations may be very considerable, as was shown by the different breaking stresses per square inch of rods of pure electrolytic copper of the same sample, but variously treated. The experiments made with these copper rods entirely confirm the results obtained by Mr. Parker and Prof. Unwin. As the material which formed the basis of the experiments, the author adopted pure electrolytic copper cast in thin rods prepared in a special manner. Owing to the difficulty of making small castings of copper, due to the rapidity with which oxidation proceeds

when the liquid metal is exposed to the air, as it is when poured into a mould, and in order to exclude the simultaneous presence of cuprous oxide (which singularly affects the strength of copper), the molten metal was not brought into contact with the air at all, but the moulds formed part of the crucible in which the metal was melted.

In the preparation of the copper rods, they were first carefully and evenly hammered, until they were somewhat flattened. They were then heated to redness for a few minutes, and plunged into cold water, and hammered until they were of square section. They were again heated to redness and quenched, and then hammered until they were octagonal. They were finally brought to an approximately circular section by passing them through grooved rolls. After a third heating and quenching, their diameter was measured by means of a micrometer, and marks were made at every half inch of their length. They were then ready for testing. The test pieces were loaded at such a rate that fracture occurred in about 15 minutes from the first application of load. This copper was analysed by Mr. Allan Gibb, and was found to be singularly pure, containing 99·99 per cent. of copper. Neither lead, silver, antimony, arsenic, tin, iron, nickel, sulphur, nor phosphorus could be detected, though they were carefully sought for. On the other hand, a minute trace of bismuth was detected. The electrical conductivity of this metal after annealing was very high. Tested by Mr. W. Gowland, a well-known authority upon the subject, it proved to be 102, pure copper being usually 100 or 101.

RESULT OF THE TESTS.

A small hydraulic machine of the single-lever type was employed for making the tests. The load is applied by a hydraulic ram, and measured by weights carried at the end of a bell-crank lever working upon steel knife edges. The maximum tension that could be exerted on the specimen was two tons, and the leverage was twelve times. The little appliance employed for determining the limit of elasticity consists of a frame carrying two multiplying levers, to the second of which is attached a mirror. A ray of light is allowed to fall upon this in a direction parallel to the axis of the machine, and is reflected upon a scale 50in. distant. The frame is supported upon three hardened steel screws, two of which are sharpened and rest in slight centres punched in the test rod, being held in them by spring clips. One of these two screws is, however, connected to the frame by means of the first of the multiplying levers, and hence any elongation of the rod is greatly multiplied by the mirror. The elongation is by this means magnified to the extent of 2000 times. The total length of each specimen was about 7in., and the length between the jaws was 4in. The calculations for the strength of the rods were made both upon the original and upon the final areas which the rods assumed before fracture, but the final section was not in all cases easy to determine. The rods fractured in one of two ways. Either the rod broke suddenly when the case presented no difficulty, or sometimes the metal did not break until it had become drawn out to a fine, knife-like edge.

Coming to consider the results of the tests as set forth in tabular form and by curves, the author first dealt with the effect of arsenic on copper. The tenacity of pure copper at 300° C. or 570° F. is 9·38 tons per square inch, with an elongation, according to A. le Chatelier, of 34·6 per cent.; whilst that of arsenical copper (the copper containing 0·2 per cent. of arsenic), according to the results of the experiments now published, is 28,230lb. or 12·6 tons per square inch at that temperature. It appears safe to conclude that the superior strength and ductility of arsenical copper is maintained at the temperatures attained by the plates of the fireboxes of locomotives; and it is harder than pure copper. This would explain the preference of the makers of locomotive fireboxes for old brands of copper, supplied before the elimination of arsenic was so fully understood by smelters.

Experiments are in progress with a view to ascertain in what order impurities hinder the restoration to copper of its original strength and ductility, after it has been strained beyond the limit of elasticity.

THE EFFECT OF PRESSURE.

The passage of iron from one allotropic modification to another is accompanied not only by a change of heat capacity, but also by a change of volume. When a mass of iron cools down from a temperature of 1000° C. or 1800° F. it also contracts, until at the point of recalescence it suddenly expands; after which it again contracts as it cools to atmospheric temperature. An experiment described in the first Report indicated the probability that pressure lowers the critical points of iron and steel. From three sets of experiments made since then with blocks of steel, it is evident that the recalescence point is lowered by pressure; but it was found that this lowering is not affected unless the load is applied at a temperature well above that at which recalescence takes place.

GENERAL CONCLUSIONS.

In the general conclusions, Professor Roberts-Austen, who in his investigations has been assisted by Messrs. Jenkins and Stansfield, states that it may be asked:—What evidence has been gathered as to the mode of action of added elements? and does it appear that the atomic volume of the added element has a dominating influence upon the mechanical properties of the mass in which it is hidden? In attempting to answer these questions grave complications arise from two causes in the case of copper.

First, it is doubtful whether the copper does or does not exist in more than one state; and the passage of the metal from one state to another may be determined by the presence of an added element. Second, it is difficult to ensure that a small quantity of an added element should remain unoxidised in the mass of copper—a difficulty which is of far less magnitude in the case of the experiments with gold. The true action of an added element may thus readily be masked by its action as a deoxidiser. Notwithstanding these difficulties, it is undoubtedly proved that bismuth, potassium, and tellurium—all of which have large atomic volumes—greatly lower the tenacity of copper. Arsenic, which has a larger atomic volume (13·2) than copper (7·1), confers strength on copper; but it is very certain that the limit of elasticity and the ductility of a metal are greatly influenced by the presence of such of the elements with large atomic volumes as have thus far been studied; and this fact may be of more molecular significance than the diminution of tenacity, to which, for the sake of simplicity, attention was mainly directed when the early experiments on gold were made.

The very important question now arises, May the effect of an added element mainly depend on its power of forming either a fusible or an infusible compound with the mass in which it is hidden? M. André le Chatelier suggests that this is the case, and that the deleterious action of an element is due to its forming a fusible compound with the mass, whilst, on the other hand, the presence of an element which forms an infusible compound with the mass promotes the formation of a fine grain and gives strength. The author points out, however, that, if this should prove to be the case, it would not remove the action of the added element from the operation of the periodic law; for there is much evidence in favour of the view that "the properties of *compounds* of the elements are a periodic function of their atomic weights." It must be remembered, as against the view of M. André le Chatelier, that the whole tendency of recent work, especially that of Heycock and Neville and of the author, is to show that when small quantities of elements are added to a metallic mass, they behave as a gas would, and remain free; and the results given in this report in the case of bismuth fully confirm this view. It remains to be seen at what point, in the cooling of a highly-heated fused mass of a metal forming a solvent, an impurity would enter into combination with a portion of the mass, and what amount of impurity of a given kind has to be present in order that it may lose its individuality. If the fusibility of a free added element were the determining cause of its action, it should be possible to classify the impurities in gold in the order of their fusibility; but any such attempt breaks down hopelessly. To turn to the action of aluminium on gold, if a small quantity of aluminium did enter into combination with a large excess of gold, it may fairly be urged that it would tend to form the very fusible gold-aluminium alloy which contains 10 per cent. of aluminium, and not the singularly infusible one which has 22 per cent. On the other hand, the most remarkable case known of the production of a very fine-grained structure, in a mass which under ordinary conditions naturally solidifies in large crystalline planes, is presented by the action of a small quantity, ½ to 1 per cent., of tellurium on bismuth; but, as 1 per cent. is a large addition, the telluride of bismuth $BiTe_3$ is probably formed, and it is not readily fusible, for its melting point is at 360° C. or 680° F.

With regard to the important molecular change which may take place in a solid metal or alloy, and of which the recalescence of steel is the most striking example, it is no small gain to have ascertained that the temperatures at which such changes occur are altered by pressure; and this seems to be a conclusion which it is safe to deduce from the result of experiments given in the present report.

The profound change which is produced in the properties of metals by alloying them is well shown by some recent experiments by Professors Dewar and Fleming. They have examined the effect of very low temperatures on the electrical resistance of pure metals and alloys; and the results tend to prove that, if pure metals could be reduced to the absolute zero of temperature, they would offer no resistance to the passage of an electric current. This is true of soft pliable metals like gold, and rigid ones such as nickel. Impure metals and alloys behave very differently; the diminution of resistance by exposure to cold is very marked, but the direction of the curves representing resistance and temperature appears to indicate that the resistance at the absolute zero of temperature would still be considerable.

COPPER PLATES FROM LOCOMOTIVE FIRE-BOXES.

The second paper, by Mr. Wm. Dean, dealt with "Tensile Tests and Chemical Analyses of Copper Plates from Fireboxes of Locomotives on the Great Western Railway." The author pointed out that as considerable differences had been experienced in the durability of copper fireboxes in locomotives on that railway, and which could not be accounted for by differences in the conditions of working, it was decided to commence testing and analysing samples of copper from fireboxes which had run long mileages, and from others which had run short mileages only. Down to March of this year eighteen samples have been selected and tested. The test pieces were sheared out of the plate, straightened by hammering cold, and planed so as to have a uniform sectional area of ½ sq. in. throughout the length tested of 8in. The testing machine used for the tensile test is a compound-lever horizontal machine of Tangyes' pattern with hydraulic cylinder, and in making the tests the pressure was applied by hand pumps. As the number of samples examined was comparatively small, and the results wanting in uniformity, Mr. Dean considers that it would probably be unsafe to form from these tests any decided conclusion as to the best composition for copper firebox plates. It would appear, however, that the presence of a small percentage of arsenic is in no way detrimental to the lasting quality of the plates.

The Junior Engineering Society.

AT the last meeting of this society, held at the Westminster Palace Hotel, Mr. Sidney Boulding, M.I. Mech. E., in the chair, a paper on "The Sanitary Engineering of Dwellings" was read by Mr. R. W. Newman, Stud. Inst. C.E., Mem. San. Inst. The author first showed how indispensable to satisfactory results efficient ventilation and disconnection were, and proceeded to deal with the appliances employed in their attainment. These included various forms of traps, disconnecting chambers, sink and bath wastes, and overflow and safe pipes. The connection of branch and main drains, the method of laying pipes, and the reasons for the absolute necessity of preserving the invert true in line and gradient, were next considered. In the subject of water closets, the construction and working of the pan and hopper, valve, wash-out, flush-down, and long-hopper closets were passed in review. The characteristics of a good closet apparatus were simplicity, self-cleansing, having no points where deposit could settle when flushed out, the whole surface to be scoured, and every part made of smooth and incorrodible material. In regard to the question of water supply, the necessity of placing cisterns in light and airy positions was mentioned, and their frequent cleansing insisted upon, reference being made to the Public Health Act (1892), London, which provides that every local authority shall (not *may*) make provision for the proper cleansing of cisterns within their district. The paper concluded with a brief summary of the most common defects met with in the drainage of houses, and, in contrast to it, the sanitary engineering of a correctly-drained house was described. An interesting discussion ensued, in which Messrs. F. R Taylor, A. W. Marshall, King, P. J. Waldram, W. Wallis, and others took part. The author, in the course of his reply, referred to the importance of not merely a perfect technical training of those responsible for the inspection of sanitary work, but also of a high moral and conscientious standard, without which the possibilities were that much of the work would be scamped. The paper was illustrated by numerous diagrams, and a collection of models of various sanitary engineering appliances were exhibited, lent by Messrs. Doulton and Co.

Metal Trade Memoranda.

The steel rail mills at the Derwent Works of Messrs. Cammell and Co. have been restarted.

The plate mills at Barrow are still standing idle, the demand for steel shipbuilding material showing no improvement.

The copper statistics published by Messrs. H. R. Merton and Co. show that the total stocks on the 15th inst. were 52,823 tons, as compared with 55,271 tons at the end of March.

The last quarterly returns of the number of iron-smelting furnaces in the United Kingdom show that the number in existence on March 31 was 746, against 751 at the end of December. The number actually at work was 353, against 359.

The members of the bar-iron trade of the West of Scotland have dissolved their Association, which has now been in existence for regulating prices for about six years. Outside competition has become so strong that it was impossible to maintain prices any longer.

The Glasgow Iron and Steel Company have ceased making basic pig iron in their blast furnaces at Wishaw, and also the manufacture of steel by the basic Bessemer process. When the alterations in the works are completed, they will be in a position to produce open-hearth steel by the Siemens process.

Negotiations which have been proceeding for some time past between the Government of Burmah and a private syndicate, relative to the concession for working the tin mines in the Maliwan Division of Mergui, have now been completed, and the concession agreed to. It is expected that the development of the property will be proceeded with immediately.

New Companies.

THWAITE, TOZER AND CO. LIMITED.—This company was registered on the 13th inst., with a capital of £6000, in £1 shares, to acquire the rights, shares, and interests of Benjamin H. Thwaite in certain patent inventions, to enter into agreements for that purpose, and to carry on the business of civil, mechanical and metallurgical engineers and chemists. B. A. Thwaite, J. H. Tozer and W. Tozer are to be the first directors; qualification. 500 shares. Many of the regulations of Table A apply. Registered by W. G. Greig, 18, Abingdon-street, S.W., solicitor.

WEBSTER'S MAGNET NAILER AND WOOD-WORK MACHINERY LIMITED.—This company was registered on the 19th inst., with a capital of £10,000, in £10 shares, to acquire, carry on, and develop the undertaking heretofore carried on by J. M. Webster and Co., in Liverpool, as patent proprietors, machine appliance and tool manufacturers, and makers of steel magnets and other materials. Wm. Clarkson, Malcolm Guthrie and T. H. Pearson are to be the first directors; qualification, £200: remuneration, 7½ per cent. of the profits. Registered by T. T. Hull, 22, Chancery-lane, W.C.

BROWN, FERNIE AND CO. LIMITED.—This company was registered on the 19th inst., with a capital of £2000, in £1 shares, to acquire and take over as a going concern the business of engineer, boilermaker, brassfounder, and coppersmith, carried on at 14, Barton street, Liverpool, under the firm of Archd. Brown and Co., and to carry on the business of engineers, boilermakers, brassfounders, smith and coppersmiths in all their branches. The first directors are A. Brown and J. Fernie, both of Liverpool; qualification, £100; remuneration to be yet decided. Registered by Walker, Son and Field, 61, Carey-street, W.C.

The Metal Market.

PRICES CURRENT.

LONDON, April 24.

COPPER opened easy and 1s. 3d. below Friday's official value, with three months at £45, and sales were shortly made somewhat freely at £44 18s. 9d. An attempt to rally prices failed, and later on cash went to £44 11s. 3d. and £44 10s., while short of and a full month passed at £44 12s. 6d., and three months at £44 17s. 6d. Operations were almost entirely of a "jobbing" character, and there was some selling on Paris account. The close was quiet at 2s. 6d. to 3s. 9d. loss on the day. Sales 800 tons. Settlement price, £44 10s. English tough, £48; best selected, £49 5s.: strong sheets, £56 15s.

TIN was unsettled, with a weaker tendency at the opening, and while the middle of May was done at about £94, three months declined 5s. to £88 10s Trading ruled dull in the afternoon, and the want of confidence led to realisations after the official close, when cash was sold at £93 10s. and one month at £93 15s. The close is easy, with cash 12s. 6d. down, other positions being correspondingly lower. Sales, 50 to 60 tons. Settlement price, £93 15s English ingots, £96 10s. Amsterdam market firm; Billiton, 55; Banca, 56.

PIG IRON has been well supported all day at 40s. 8d. cash, of which 3000 tons were taken, and the market closes with buyers at this figure, or ½d. above the previous price. Middlesbrough was inquired for at 34s. cash and 34s. 5d. three months. Settlement prices:—Scotch, 40s. 8d.; Middlesbrough, 34s.; hematite, 45s.

TINPLATES remain dull, with I.C. cokes. f.o.b. Swansea, at 11s. 7½d. to 11s. 9d.

LEAD shows no appreciable alteration. Spanish, £9 13s. 9d. to £9 15s. English, £9 15s. to £9 17s. 6d

SPELTER has ruled firm, with early business at £18 1s. 3d. for prompt shipment, and closes with sellers at £18 2s. 6d., the market being fully 1s. 3d. better on the day.

ZINC SHEETS.—Silesian steady at £20 15s. ex ship; Belgian firm, with V.M. brand at £20 17s. 6d. ex ship, and £20 15s. f.o.b. Antwerp.

OFFICIAL CLOSING QUOTATIONS.

	To-day.	
	£ s. d.	£ s. d.
COPPER—		
G. M. B.—Cash	44 10 0	44 17 6
" Three months	44 17 6—	45 5 0
TIN—		
Fine foreign—Cash	93 10 0—	94 0 0
" " Three months	88 10 0—	89 0 0
Australian—Cash	94 7 6—	94 17 6
PIG IRON—		s. d.
Scotch warrants—Cash		40 8
" One month		40 10½
Middlesbrough—Cash		34 0
" One month		34 2
Hematite—Cash		45 0
" One month		45 2

GLASGOW, April 24.—The business transacted on the pig iron market covered 8000 tons Scotch at 40s. 7½d. to 40s 8d. cash, 500 at 40s. 9½d. cash 30 days, 3000 tons hematite at 45s. 11½d. three months fixed, and 1500 tons Cleveland. The market was very steady on the whole, and the last prices were a shade stiffer than on Friday. Scotch shipments for the week 7673 tons, being 53 tons more than the corresponding week, and reducing the decrease for the year to 1536 tons.

QUOTATIONS:—

	Scotch.		Middlesbrough.		Hematite.	
	Cash.	1 m'th.	Cash.	1 m'th.	Cash.	1 m'th.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Highest	40 8½	40 11	34 0	34 2	45 0	—
Lowest	40 7½	40 10½	34 0	34 2	45 0	—
Close	40 8	40 10½	34 0	34 2	45 0	—
Prev. close	40 7½	40 10	34 0	34 2	45 3	45 5

Official Gazette.

Partnerships Dissolved.

H. T. CLOAKE, H. T. CLOAKE the younger, and F. W. CLOAKE, Bute Docks, Cardiff, steamship brokers and steamship managers, marine surveyors, and consulting engineers.

J. HIRST and A. E. VICKERMAN, under the style of J. Hirst and Co., Huddersfield, engineers and millwrights.

C. F. COCKSHOTT and J. E. JOWETT, brass and malleable iron founders, Bradford, under the style of Cockshott and Jowett.

R. E. POWELL and D. T. POWELL, printers' engineers, etc., Ludgate Hill, E.C., under the style of J. M. Powell and Son.

Scotch Sequestrations.

JAMES R. WATSON, ironfounder, Glasgow; April 24, at 12, Faculty Hall, Glasgow.

ALEXANDER SHANKS AND SON, engineers, Arbroath, and JAMES SHANKS, machine maker and engineer, Arbroath, sole partner of Alexander Shanks and Son; April 25, at 1, White Hart Hotel, Arbroath.

Letters to the Editor.

*** *We do not hold ourselves responsible for opinions expressed by correspondents.*

*** *The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

*** *Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

RAILWAY SPEED.

To the Editor of THE MECHANICAL WORLD.

SIR,—The highest speed ever run on rails in this country is 81 miles an hour, and that was attained 40 years ago.

Your correspondent, "Compound," must beware of speed indicators placed upon driving wheels. I of course know that when a North-Eastern engine was running at 79 miles an hour, the driving wheels commenced to "slip," causing the speed indicator to show 86, 90, and 100 miles an hour, but the moment the steam was shut off the true speed of 79 was again shown Compound locomotives in England have so far proved a failure, and some of the very latest express engines are being built on the non-compound principle.

CLEMENT E. STRETTON, C.E.

Saxe-Coburg House,
Leicester, April 24.

Miscellaneous Items.

The Commercial Cable Company of New York have decided to lay a third submarine cable across the Atlantic Ocean.

In 1892 the railway companies of the United Kingdom employed no fewer than 380,000 men, and paid away in wages over £20,000,000.

While boring for water on the Earl of Dysart's estate at Silk Willoughby, a village near Sleaford, Lincolnshire, the workmen have penetrated a seam of coal about 27ft. below the surface. The stratum varies in thickness from 6in. to 12in.

It is stated in Paris that M. Ehardt, a gun manufacturer at Zella, has invented a new cannon, which for rapid firing is said to surpass every gun yet produced. Herr Krupp is reported to have offered 3,000,000 marks for it, but the inventor declined the offer.

The receipts of the City and South London Electric Railway Company for the week ending April 16 were £861, against £734 for the corresponding period of last year, or an increase of £127. The total receipts for 1893 show an increase of £1222 over those for the corresponding period of 1892.

Another old wooden line-of-battle ship, the "Victoria," now at Portsmouth, has been ordered to be sold out of the service to be broken up. The "Victoria," which is of 6959 tons and 4191 H.P., was launched at Portsmouth in 1859. The original cost of her hull was £150,578, and she was engined by Messrs. Maudsley at a further cost of £66,000. She was last paid off in August, 1867.

Plans have been completed for a power station at outlet of the Huella Lake, in Sweden, where there is a large water power. At present four turbines, each of 100 H.P., will be put in, one of them to be held in reserve, in case of a breakdown. The power will be transmitted by overhead wire to Grangesberg. The electric-lighting station is six miles and the station from which power will be distributed is eight miles from the dynamo-house.

Nickel steel forgings for an experimental 8in. breechloading rifle have been finished, and the manufacture of the gun will begin at once at the naval gun factory in Washington. Nickel steel has never been used in the manufacture of guns, and it is thought that the physical characteristics, such as increased elasticity and elongation, render it specially adapted for guns subjected to high pressures with nitro powders. The forgings for this particular gun have 3·15 per cent. of nickel. The gun will be 304in. long, and will weigh 31,300lb.

A method of soldering aluminium and its alloys is recommended by Mr. G. Wegner, a goldsmith, of Berlin. The method consists essentially of the use of a flux made of 80 parts of stearic acid, 10 parts of chloride of zinc, and 10 parts of chloride of tin. Any ordinary soft solder can be used, but the best solder is composed of 80 parts of tin to 20 parts of zinc. After the pieces of metal have been cleaned and damped with the flux the solder is applied in the usual way. This flux and solder can be used for soldering aluminium and its alloys or for attaching them to any other metals.

We note with pleasure that a European edition of the "Engineering Magazine (New York) has been inaugurated. The magazine, we may add, is published simultaneously at New York, London, and Melbourne on the 1st of the month. The April issue contains articles on "The Industrial Problem in Australia," "A Decade of Marvellous Progress," "English and American Railways," "Fallacies and Facts as to Immigration," "The Dearness of 'Cheap' Labour," "Would the Pan-American Road Pay?" "Refrigeration from Central Stations," "Conditions of Forestry as a Business," "An Early Engineering Magazine," and "The Past and Future of Engineering." The London publisher is Mr. Geo. Tucker, 1, Salisbury-court, Fleet-street, and the price of the journal one shilling monthly.

A series of experiments have recently been carried on at Chicago with a view of finding some satisfactory and at the same time an inexpensive means of treating coal so that in burning it will not produce smoke. This was done by dumping a certain amount of coal into a coke oven previously heated, and following the process ordinarily used in coke-making. As soon, however, as the first fractions are driven off by the heat of the oven it is closed, allowed to cool sufficiently, and the semi-coke is removed. This is further cooled and then ready for use. Taking a coal containing 30 per cent. of volatile matter, this process will reduce it to 18 per cent., increasing the fixed carbon in a corresponding ratio. The length of time which the coal remains in the oven depends largely upon the characteristics of the coal itself, but varies from four to eight hours.

The London and North-Western Rail-way Company commenced a series of experiments with its large engine, the "Greater Britain," on the 17th inst. The engine was brought out of the Crewe steam sheds at midnight, hitched on to the Scotch mail, and took the train to London. After a short stop the engine restarted at ten, and took the train to Crewe. After coaling, it conveyed the train on to Carlisle, and was timed to be back again at Crewe at midnight with the Scotsman for the south, thus doing 600 miles in the 24 hours. It then restarted on its journey to Euston. It is arranged that the "Greater Britain" shall do this journey from London to Carlisle and back to London, 600 miles, every day this week, and scarcely will be allowed at any station to get the steam down. The engine is being tested for speed, and also for extra weight-drawing capabilities and economy in consumption of fuel.

There has just been completed by Messrs. Messum, the well-known boat-builders, of Richmond, to the order of the Nizam of Hyderabad, a pleasure-boat peculiar in shape and, for its size, exceedingly costly in construction. Two boats of the size of a large skiff have been joined side by side by a deck, upon the extremities of which rise a number of finely-carved pillars supporting a pagoda-shaped roof. The whole of the woodwork is of teak. As an instance of the great expenditure of labour upon the boat, which is only 28ft long by 14ft. wide, it may be stated that the tiles of the roof are composed of some 3000 small pieces of teak, most of which have had to be specially cut. There are no windows, but all four sides of the barge will be hung with pure silk of the richest quality, while the deck will be cushioned in the same costly way to a height of some feet. The barge will be propelled by two feathered paddles, placed between the bows and sterns of the two supporting boats and turned by handles after the manner of a small canoe. It is intended for use on a lake near to which the Nizam has a summer palace.

Queries.

☞ **Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.**

☞ **Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.**

BRIGHTENING CHAINS.—Can any correspondent inform me what material to use in a shaker to brighten chains?—W. B.

WOOD'S AUTOMATIC PRESSURE RELIEF VALVE.—Required the address of Mr. W. Wood, the maker of the above.—B. AND CO.

COST OF M.S. AND L. RAILWAY.—Can anyone inform me what was the cost per mile of the M.S. and L. Railway from Manchester to Grimsby?—LOW DROP

LOCOMOTIVE STAY TAPS.—Can any reader furnish me with the addresses of firms who are makers of locomotive stay taps suitable for fireboxes?—GEORGE.

CLEANING BOILER TUBES.—Will some reader describe a useful tool to remove hard, thick scale from cross tubes in a vertical boiler? Tubes 9in. diameter and 4ft. 6in. long—NOVICE.

DYNAMO.—Can any reader inform me whether a dynamo, wound to give 10 ampères at 55 volts at a given speed, would be damaged if driven at twice the speed; and, if not, what output would it give?—J. O.

POWER RENTAL.—I am desirous of supplying steam power to a tenant from an engine driving his own works. How is the value of such to be ascertained, and what is the fair price for 100I.H.P. per week of 54 hours; also for 8I.H.P. similarly supplied power?

STEAM REVERSING GEAR.—I should be much obliged if any reader will explain the working of a steam reversing gear for locomotives, which I have seen on the following railway companies' engines:—Glasgow and South-Western, Mersey Tunnel, and South-Eastern. A sketch would assist me.—F. TURTON.

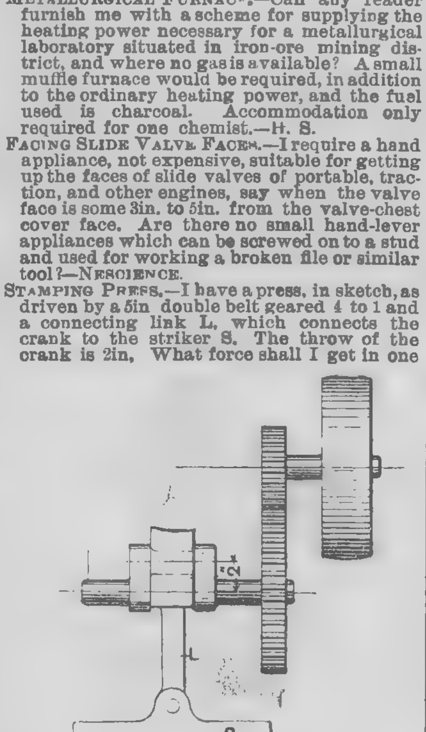
THEORETICAL DIAGRAMS.—Will any reader sketch and describe the theoretical indicator diagrams which would be obtained from a set of triple-expansion engines, having given—Load on safety valves, 150lb.; height of barometer, 30in.; ratio of cylinder volumes, 1, 2½, 5; total ratio of expansion, 8.—HYPER.

TUBBING.—What system ought to be adopted in the renewal of tubbing in a shaft which has become faulty in the middle of a length of tubbing 25 fathoms from the surface—pit 15ft. and 100 fathoms deep? Kindly explain what method to use to secure the greatest safety and make the most permanent work.—J. M.

METALLURGICAL FURNACE.—Can any reader furnish me with a scheme for supplying the heating power necessary for a metallurgical laboratory situated in iron-ore mining district, and where no gas is available? A small muffle furnace would be required, in addition to the ordinary heating power, and the fuel used is charcoal. Accommodation only required for one chemist.—H. S.

FACING SLIDE VALVE FACES.—I require a hand appliance, not expensive, suitable for getting up the faces of slide valves of portable, traction, and other engines, say when the valve face is some 3in. to 5in. from the valve-chest cover face. Are there no small hand-lever appliances which can be screwed on to a stud and used for working a broken file or similar tool?—NESCIENCE.

STAMPING PRESS.—I have a press, in sketch, as driven by a 5in double belt geared 4 to 1 and a connecting link L, which connects the crank to the striker S. The throw of the crank is 2in. What force shall I get in one



blow on the table A, and how shall I calculate the force if a fly-wheel is added, say 3ft. diameter and weighing 300lb? The thickness of the material to be stamped is $\frac{1}{16}$in., the depth about 3in., and the area of stamp 400sq. in.—YOUNG DRAUGHTSMAN

DYNAMO WINDING.—Can any reader oblige me with the proper winding for an E.P.S. type dynamo of the following dimensions (in centimetres), so as to obtain at least 4 volts 3 ampères at a speed of about 2000 revolutions per minute:—Length of magnet bar, 11; length of yoke piece, 8·1; width of magnet and yoke piece, 5·3 each; depth of yoke piece, 2·5; thickness of magnet bar inside bobbin, 3; diameter of armature, 5; length, 5·3; air gap, ½ millimetre all round? It has a laminated armature, with 12 interruptions $\frac{3}{16}$in. wide by ¼in. deep, and a corresponding number of sections in the commutator. The magnets are of Swedish cast iron. I have tried it with 2000 turn of No. 38 B.W.G. on the field and 120 turns of No. 26 B.W.G. on armature, but can get hardly any current.—E. P. S. TYPE.

Replies.

☞ **Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.**

☞ **Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.**

JOHN PARANIA.—See reply in our next issue.

CARDIFF.—Your query is intelligible without a sketch.

ANXIOUS MARINE.—We should advise a three-bladed propeller.

FRED H.—Yes Apply to Messrs Alldays and Onions Engineering Company, Birmingham.

R. DUCKWORTH.—If you apply to Mr. Bernard Dawson Malvern Link, he will give you full particulars

S. C.—Cover with frost felt and then with polished mahogany strips, held together by brass bands surrounding the whole.

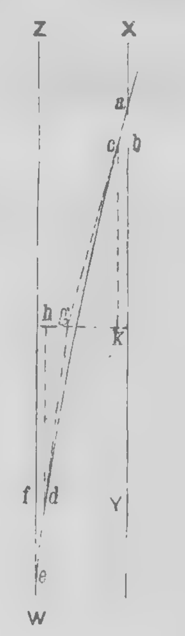
YOUNG APPRENTICE.—See our last issue, page 155. The price may be had from Messrs. Gay and Bird, King William-street West, Strand, London.

F. NICHOLL.—We have used the celluloid slide rule as supplied by Messrs. John Davis and Son, of Derby, and find it most useful for ordinary purposes.

FISHER.—To prevent the barrels of your rifles from rusting, clean them thoroughly and apply with a rag nitric or sulphuric acid diluted with the same quantity of water.

H. J. VARLOW.—The only plan we can suggest is to plane the valve face over until all imperfections are removed; then pin or screw on a thin plate either to the valve or the face to make up the original over-all dimensions.

RAIL CROSSINGS.—Given the gauge and the angle of crossing of rails, what rule is generally adopted to obtain the radius of the curve and the rails?—R. A. J.—*A.*—Let $a\,b\,c$ represent the crossing, and X Y, Z W the two rails of a main line, into which the branch line, one of whose rails is $a\,c\,d\,e$, turns. Now a straight line through the crossing produced $a\,c\,g$, and a straight line through the point produced $e\,d\,g$, constitute the two tangents to the circular curve connecting them, and for this curve to run fair and tangentially into each of them, it is essential that $c\,g$ and $d\,g$, the two "tangent lengths," be equal. The problem then is to find the distance $m\,f$ from end of crossing to heel of point, which is such that these tangent lengths be equal. This being found, it is easy



to set out and determine the circular curve connecting them. The given conditions are the head and angle of the crossing and points, and the distance $k\,h$ perpendicular to the rails between the end of the crossing c and the heel of the switch d. From these we can get two equations:—

Let a = angle of crossing, say 7° 10′, or 1 in 8.
" b " point, say 5° 43′, or 1 in 10.
" $k\,h$ = 4ft.
" $k\,g$ x.
" $h\,g$ y.

Then cosec. $a \times x$ = cosec. $b \times y$, and $x + y$ = 4ft. From the first

$$8{\cdot}01\,x = 10{\cdot}01\,y$$

$$\therefore x = \frac{10{\cdot}04}{8{\cdot}01}\,y = 1{\cdot}25\,y.$$

Substituting this value of y in the second equation,

$$2{\cdot}25\,y = 4\text{ft.}$$

$$\therefore y - 1{\cdot}78\text{ft.},$$

$$\text{and } x = 4 - 1{\cdot}78 = 2{\cdot}22\text{ft.}$$

This gives x and y—*i.e.*, $k\,g$ and $h\,g$. Now to get $c\,k$ and $h\,d$,

$$c\,k = \text{cot. } a \times x = 7{\cdot}95 \times 2{\cdot}22\text{ft.} = 17{\cdot}64\text{ft.}$$
$$h\,d = \text{cot. } b \times y = 9{\cdot}99 \times 1{\cdot}78\text{ft.} = 17{\cdot}78\text{ft.}$$

Adding these, we get 35·42ft. as the value of $m\,f$. Now place a stake at g, the intersection

of the tangents, and read the angle $c\ g\ d$, which is the "angle of intersection" for the curve. The tangent of half this angle multiplied by the tangent length $g\ d$ or $g\ c$, which can be measured on the ground or calculated, will give the radius of the curve required. All above measurements are supposed to be taken to centre of rails. If R. A. J. has any further difficulties, I shall be glad to try and solve them.—T. J. B.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

10th April, 1893.

7282 CONDENSING ARRANGEMENTS for STEAM CYLINDERS. G Bennett.
7283 COMPOSITION for GLUEING PURPOSES.* F Hess.
7285 APPARATUS for LIGHTING MINERS' SAFETY LAMPS. J Graham and H Chapman.
7287 MOTOR. G J J Legrand.
7289 AMALGAMATING APPARATUS. W P Thompson. (*J Jelfy*, Austria.)
7292 EXHAUST SCRUBBER for PETROLEUM MOTORS.* J Walker.
7297 SECONDARY BATTERIES. W J S Barber-Starkey.
7301 WIRE. A Macdougall.
7302 HIGH-PRESSURE STEAM ENGINES. W Schmidt.
7303 APPARATUS for DRYING by MEANS of HOT AIR.* C A L Bruckmann.
7305 FIREBOXES and TUBES of STEAM BOILERS of the LOCOMOTIVE TYPE.* W Malam.
7311 SELF-RIGHTING OIL CAN or OILER. W G Gass.
7322 MEANS for PRODUCING MOTIVE POWER. C Trowbridge.
7327 MOTIVE POWER MACHINERY. G H Trow.
7331 GOVERNING APPARATUS for STEAM ENGINES to PREVENT RACING or OVER-RUNNING. S Dear.
7332 MACHINE for MOULDING PLATES or BLOCKS HAVING INCLINED or TAPERED SIDES.* J Böhm.
7335 NAIL-DRIVING APPARATUS.* J L Kornder.
7342 CONDUCTORS for the DISTRIBUTION of ELECTRICAL ENERGY. A Bergtheil and R A Marples.
7345 ALARM THERMOMETERS.* I Cahn.
7346 APPARATUS for ACTUATING POINTS and SIGNALS upon RAILWAYS. A R M Simkins.
7347 SELF-ABSORBING REFRIGERATING APPARATUS. E C Buik.

11th April, 1893.

7355 FUEL ECONOMISERS. R Baron and T W F Knight.
7360 VALVES for CONTROLLING the SUPPLY of STEAM to STEAM ENGINES. G W Linford.
7387 MACHINES for ELECTRICALLY WELDING METALS. W P Thompson. (*C L Coffin*, United States.)
7389 APPARATUS for ELECTRICALLY WELDING or WORKING METALS. W P Thompson. (*C L Coffin*, United States.)
7400 GAS REGULATOR or GOVERNOR. J H Higginson.
7406 FURNACE BARS. G C Downing. (*J Rivet*, France.)
7407 ELECTRIC METERS. J W Jones.
7410 APPARATUS for COUPLING SHAFTS. A Beugger.
7412 UNLEAKABLE TAP or VALVE. E G Warner.
7416 BRAKE APPARATUS for RAILWAY WAGONS and CARRIAGES. G E Church and G W Ettenger.
7417 FRAMES of BOGIE TRUCKS for RAILWAY CARRIAGES and WAGONS. G E Church and G W Ettenger.
7418 METALLIC UNDERFRAMES of RAILWAY CARRIAGES and WAGONS. G E Church and G W Ettenger.
7423 TELEGRAPHING.* W H Fahrney.
7424 ELECTRIC ARC LAMPS. A G Waterhouse and The Waterhouse Electrical Manufacturing Company Limited.
7426 GAS ENGINES. H T Dawson.
7428 CAR COUPLING. S Shattuck and others.
7431 PERMANENT WAY of RAILWAYS. R D Culver.
7433 PETROLEUM or OIL ENGINES. G A List and others.
7434 ROTARY MOTORS and PUMPS.* J Y Johnson. (*F H Cathcart*, United States.)
7435 APPARATUS for PURIFYING FEED WATER.* C E Whitmore.
7437 MICROPHONE.* H H Leigh. (*C Mildé, Son and Co.*, France.)

12th April, 1893.

7445 SCUTCHER for WOOD-MOULDING MACHINES. J P Cerry and Co. Limited.
7450 FINISHING PAPER on PAPER-MAKING MACHINES. W Knowles and J Mather.
7453 INGOT MOULDS. W Wilkinson.
7455 FLUID METERS. B M Fletcher.
7462 CENTRES for SETTING OUT WORK. P Spencer.
7464 MIXING PULP for PAPER MAKING. J Mather and W Knowles.
7466 VARIABLE SPEED and REVERSING MECHANISM for GAS or VAPOUR MOTORS. P Burt.
7467 GAS PRODUCERS. E J Duff.
7470 ELECTRIC RAILWAYS and TRAMWAYS. P Willis. (*J B Sheldon and others*, United States.)
7471 ELECTRIC ANNUNCIATORS.* E R Wilder.
7472 SCREW-CUTTING LATHES. H Jermy.
7473 VENTILATORS. J Shaw.
7479 FRICTION DRIVING APPARATUS. W S and C R Boult.
7488 ELECTRIC BATTERY APPARATUS. J A Archer.
7491 INCANDESCENT ELECTRIC LAMPS. T Oddy.
7493 BUFFING and DRAW GEAR for RAILWAY WAGONS and CARRIAGES. G E Church and G W Ettenger.
7494 PUMP VALVES. A H E Bercham.
7496 LIQUID GAUGES. C Y Payne.
7497 MOTIVE POWER ENGINES, ACTUATED by the COMBUSTION of a MIXTURE of GAS or VAPOUR with AIR. E Edwards. (*P Hellmich*, Germany.)
7498 PIPE JOINTS. W Sykes.
7509 INCANDESCENT ELECTRIC LAMPS. J Cooper.
7510 GAS FIRE BOILERS. G H Taylor.
7513 TUBES for USE in all KINDS of STEAM GENERATORS.* S Biosca.

13th April, 1893.

7521 SMOKE CONSUMING APPLIANCES for STEAM BOILER FURNACES. W Crowther and others.
7526 CALCIS ANTI-CORRODANT and ANTI-INCRUSTANT for USE in STEAM BOILERS. R Innes and W Jackson.
7527 ELEVATED RAILWAYS. E Haughton.
7528 STEAM or OTHER FLUID PRESSURE ENGINES. H Turner.
7535 BELT FASTENER. T Thorpe.
7541 SAFETY APPARATUS for PIT CAGES and HOISTS. J T Calow.
7549 SIGNALLING BETWEEN and on NAVIGABLE STEAMSHIPS with the VIEW of LESSENING the RISK of COLLISION. J Green.
7551 AUXILIARY CONDENSING STEAM PUMP for RAISING of WATER with the ATMOSPHERIC PRESSURE. J W and C Kiddle.
7555 MICROMETER GAUGE. J P Lavigne and W F Day.
7556 LOCOMOTIVE, MARINE, and OTHER BOILERS. F W Webb.
7557 DRIVING BANDS and PULLEY COVERING. J W Hartley.
7558 COMBINED REVERSIBLE VALVE and AIR PIPE. W Wheeler.
7559 COMBINED SWITCH and LAMP-HOLDER. W H Scott.
7560 APPARATUS for FIXING CUTTERS in BORING BARS for LATHES, DRILLING, BORING, SLOTTING, and LIKE MACHINES. G Johnson.
7561 ELECTRIC RAILWAY SIGNALLING. I A Timmis.
7570 PRISMATIC SUN CHRONOMETER for ASCERTAINING CORRECT MEAN TIME DIRECTLY from the SUN. E E Scott.
7575 ELECTRICAL APPARATUS for HEATING WATER AUTOMATICALLY. C H Prichard.
7581 ELECTRIC ARC LAMPS. A D and F M Lewis.
7588 LOCK-NUT WASHERS. P A Craven.

14th April, 1893.

7600 ELECTRICAL HEATING APPARATUS. Sir D L Salomons, Bart.
7603 REDUCING and STOP VALVE for WATER or OTHER FLUIDS. J Murrie.
7622 BOILER COMPOSITIONS for INTERNAL APPLICATIONS. F A Clayton.
7623 APPARATUS for the CONVERSION of the ENERGY of ELECTRICITY into that of LIGHT. R Wood.
7633 ADDING and CALCULATING MACHINES.* W P Thompson. (*C H Webb*, United States.)
7638 ROTARY MOTORS. A J Boult. (*P Baumert* and *E Niethe*, Germany.)
7639 ROTARY MOTORS or PUMPS. A J Boult. (*P Baumert* and *E Niethe*, Germany.)
7643 FEED-WATER HEATING APPARATUS. R Stewart.
7645 APPARATUS for SHOWING the PHENOMENA RESULTING from the APPLICATION of HEAT to CRYSTALS. Sir D L Salomons, Bart.
7647 RAPID TELEGRAPHIC TRANSMISSION. C Laugdon-Davies.
7651 SCREW NUTS. J D Ireland.
7663 PADDLE WHEEL for PROPELLING SHIPS. G A Haig.
7666 CENTRIFUGAL DRYING MACHINES. W Burkhard.
7667 OVALLE'S FURNACE. A O Vicuna.

15th April, 1893.

7687 CONDUCTOR for ELECTRIC and TELEPHONE WIRES. N D I O Gold.
7688 GODIVA GAS ENGINE. W S Payne and A E James.
7694 CRUSHING MACHINERY. T Thompson.
7697 DYNAMO-ELECTRIC and ELECTRO-DYNAMIC MACHINES. H Robinson.
7701 SMOKE-CONSUMING APPLIANCES. E Harrison.
7702 ELECTRIC SIGNALLING APPARATUS for RAILWAYS.* J Y Johnson. (*J W Lattig* and *W F D Pascoe*, United States.)
7703 ELECTRIC SIGNALLING APPARATUS for RAILWAYS.* J Y Johnson. (*J W Lattig* and *W F D Pascoe*, United States.)
7711 ELECTRICAL ACCUMULATORS or SECONDARY BATTERIES. P Schoop.
7712 PARACHUTE SAIL for STEERING BALLOONS.* T Schneider-Preiswerk.
7713 GLAND JOINT for ELECTRICAL CONDUCTORS. W C Johnson.
7717 OIL, SPIRIT, or GAS ENGINE. W Pullen
7718 APPLIANCES in CONNECTION with MINING OPERATIONS. W Charlton.
7726 ROTARY STEAM ENGINES. C Smith. (*G Maarat*, Denmark.)
7734 HYDRAULIC APPARATUS for ACTUATING and CONTROLLING the DISTRIBUTING VALVES of MOTIVE FLUID ENGINES. C Bonjour.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to SIR H. READER LACK, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

All who are practically engaged in Mechanical Engineering or Scientific Industries are invited to avail themselves of THE MECHANICAL WORLD columns for information. We are glad to help the diffident, and, so far as we can, remove the obstacles which frequently prevent practical men from communicating their ideas.

We wish it to be distinctly understood that we cannot, for any consideration, and will not knowingly, allow our editorial columns to become the vehicle for mere advertisements of machinery, apparatus, or anything that falls within our province to notice.

Every correspondent should forward his name and address, not necessarily for publication unless so desired. We do not undertake to return MSS. unless specially requested, and in such cases stamps should always be sent.

All communications relating to editorial matters should be addressed to the Editor of THE MECHANICAL WORLD, at the Manchester, and not the London, Offices.

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All remittances payable to EMMOTT AND COMPANY LIMITED, Publishers, either at New Bridge Street, Manchester, or 85, Strand, London, W.C.

FRIDAY, MAY 5TH, 1893.

New Creosoting Plant.

METALLIC railway sleepers do not find favour in this country, and although various methods of preserving the timber used for this purpose have been introduced from time to time, creosoting still appears to be the only reliable and generally satisfactory means of protection. The London and North-Western Railway Company have lately erected at Earlestown a large creosoting plant, but, in this instance, it is for the purpose of treating coal and cattle-car bodies and frames after they are put together. It comprises a cylindrical creosoting chamber 12ft. 6in. internal diameter by 22ft. long, made of ⅝in. steel plates, and there are storage tanks for holding the creosote, which are placed below ground close to the creosoting chamber, to which they are connected by pipes. The chamber is fitted with a glass gauge, pressure gauge, and escape valve loaded to give a pressure inside the chamber of 100lb. per square inch. At one end of the chamber is a door or cover, which is supported by a crane fixed to the side of the chamber; when closed it is firmly held in position by 48 cast-steel cramps, which are hinged to the chamber, the joint between the cover and the chamber, which is of the ordinary external and internal type, being made with lead. Rails are fixed inside the chamber, on which the car to be creosoted is run on its own wheels. As soon as the car has been run inside, and the end cover made secure, a vacuum is created in the chamber by means of a Meldrum ejector; at the same time the creosote in the storage tank rises through the pipe into the chamber. When the chamber is filled the filling connections are closed, the ejector stopped, and pressure pumps turned on.

Tramways and Telephony.

IT is satisfactory to find that decisive steps are being taken to determine the relative positions of telephone and tramway companies in the use of the "earth" as return for the electric current. At present, as mentioned in our issue of the 21st ult., the telephone companies claim a monopoly in this direction, and where such should not be permitted to exist. The Electric Traction Association, formed to protect the interests of tramways intending to introduce electric power on their lines, and to deal with the demands of the telephone companies, has now approached the Board of Trade on the matter. Last week a meeting was convened by the Board of Trade at the Commercial Department to consider the subject, when members of the Traction Association attended. The proceedings were, however, of a private nature, but it is to be hoped that at the next gathering representatives of the Press will be admitted. The Board of Trade having now consented to take the matter in hand, forebodes well for a proper understanding being arrived at, which we trust will soon be the case.

A New Magazine Rifle.

SOME recent trials have been made with an automatic magazine rifle invented by Messrs. Woodgate and Griffith. It is stated that with this gun the whole of the seven cartridges contained in the magazine can be fired within two seconds, and, allowing ample time for substituting fresh cartridge cases in the magazine, 105 shots per minute can be fired. At the same time, a much greater accuracy of aim than with other rifles is obtained, owing to the fact that it is not necessary to lower the weapon to reload until the seven cartridges in the magazine are exhausted, when the case, being empty, drops out automatically. The magazine is permanently fixed underneath the gun in advance of the trigger guard, and has the immense advantage of being loaded from below. The barrel is encased in wood about 9in. from the muzzle, which prevents undue heating. The mechanism is extremely simple, consisting of a single strong bolt travelling in a shoe and two springs. The spring which works the bolt is placed on the outside of the shoe, and, if broken, can be easily replaced in a few seconds. The gun can also be used, if required, as a single loader by simply sliding a button placed at the side of the stock.

Cost of Lighting.

IN a paper read recently before the Civil and Mechanical Engineers' Society, Mr. F. B. Nicholson gave some figures from his own experience regarding the cost of electric lighting. He finds, when replacing gas in houses, that an incandescent electric lamp of 8C.P. can generally be substituted for the ordinary gas burner, and that with gas at 3s. 2d. per thousand, the cost of the electric light, with current supplied at 6d. per Board of Trade unit, amounts to about 10 per cent. more than that of gas. In the case of offices, different circumstances prevail. Lamps of 8C.P. will not meet the requirements of most cases, and those of 16C.P. will be most universally needed, as offices generally use Argand or some other improved burner, which gives more light than the ordinary domestic burner. Under these circumstances, and as exact figures are at present not forthcoming on this point, the author considers that electric light will cost more than gas in the proportion of approximately 4 to 3. With regard to factory lighting, he is unable to give any reliable information, as so many plants are run from the factory engines, and which renders it impossible to arrive at the exact cost of the power. Generally the expense is much below that of other illuminants. Coming to consider the average receipts per 8C.P. lamp per annum obtained by different companies, the author gives the Notting Hill Company as 7s. 6d.; Chelsea Company, 7s. 7d.; Kensington Company, 7s. 9d.; Westminster Corporation, 9s. 7d.; Electricity Supply, 16s. 11d.; and the St. James's and Pall Mall Company, 19s. 5d. In the latter two cases exceptional circumstances prevail, as the districts supplied are well provided with customers who burn their lights for exceptionally long periods.

Lighting Small Towns.

CONSIDERABLE prominence is given by German electrical journals to lengthy illustrated descriptions of a small central electric-light station recently started at Fürstenfeld-Bruck, in the province of Brandenburg, Prussia. The main features of interest seem to be (1) the smallness of the area supplied, the town served only containing some 3000 inhabitants; and (2) the running of single-phase alternating-current motors from the secondary or distributing circuits. The generating station is situated at Schöngeising, using the water of the river Amper for the motive power, and the distance the current is transmitted is five miles. At present the plant comprises two Knop turbines, which drive a countershaft from which are operated by belting two Brown alternators and an exciter. The alternators each give 33,000 watts, the pressure being 2600 volts, of which 200 volts are lost in transmission. The wires, carried overhead, are of 6 millimetres diameter, and the low-pressure current in the secondary circuit is practically 100 volts. On reaching Fürstenfeld-Bruck, the high-tension current passes to different transformer boxes, the converters being oil insulated. After conversion, the current at 100 volts is distributed by overhead conductors, which in this case allow of house connections being made at a figure more than six times cheaper per house than would have obtained if underground cables had been adopted. At the moment 1500 incandescent lamps, seven arc lamps, and 12 motors of the single-phase alternating-current type, are connected to the secondary circuits. The charges made for current are low, and the result has been the adoption of the electric light in houses where previously one or two oil lamps were used.

Municipal Enterprises.

THE municipalisation of electric-light undertakings is rapidly following those of drainage, water and gas, in which all citizens are concerned. Bradford was the first to lead the way in the case of electricity, and its example has been or is being imitated by Bristol, Manchester, Southampton, Glasgow, Dundee, and other towns, the latest addition being Edinburgh. The work of supplying the electric light is far better in the hands of municipalities or other local authorities than in the possession of companies, some of which are not free from the suspicion of being formed for some special purpose of the promoters. Everywhere there is a demand for more light, and especially in the case of the illumination of streets and other thoroughfares. By making electric light enterprises municipal undertakings, which do not work for the largest amount of profit as do companies, the supply of light for public illumination can be greatly extended at very little extra cost, and be provided cheaply for private consumers, whilst the profits which may accrue through the working of the plant can be utilised in reducing the rates. It matters little to electrical engineers whether the supply is rendered by the one or the other, but to the ratepayers it means a great deal. By all means let the work of municipalisation proceed for the good of the general community and not for the well-being of a few.

A Portable Hoist.

A FOUR-WINCH electric hoist has been brought out for use on shipboard, or on wharves or docks. It consists of a strong cast-iron frame, carrying a 45H.P. electric motor and two heavy shafts, each having a spool keyed on each end over a bronze bushing. This facilitates the removal of the spool when necessary, whereas an iron-to-iron joint will rust fast when exposed to salt spray. Each spool is independent of the others, so that a number of loads may be raised, lowered or held independently. Two safety pawls on each spool are held out of operation by centrifugal force when a load is being hoisted, but they immediately engage with teeth on the bearing-cap should the current fail, and will thus prevent the load from running down. The motor is enclosed, with the exception of small openings giving access to the bushes and armature bearings, and these are closed when the hoist is in operation. The apparatus for controlling the hoist is placed below the motor within the frame, where it is protected from mechanical injury and moisture. The normal speed of the motor is 425 revolutions, and the voltage, 110, 220, or 500 volts as it may be designed; at 110 volts the current is 360 ampères. The hoist will lift 27cwt. on two spools at 250ft. per minute; it is mounted on wheels, and its total weight is 3 tons 11cwt. The hoist has been designed to satisfy the varied requirements of ship and dock work, and is said to offer special advantages to which the steam hoist cannot lay claim.

Sugar-making Machinery.

XXXI.

Sugar-mill Gearing.—The power of the engine is usually transmitted to the mill, and the speed reduced, by means of a heavy train of compound gearing, firmly secured to a massive cast-iron bedplate on the same level as that of the engine. At one time the necessary reduction of speed and multiplying power was obtained by the use of single gear, consisting of a pinion and one very large spur wheel; but this plan has been gradually abandoned for the more modern arrangement of compound or double gear.

Owing to the enormous stresses which may be set up in sugar mills, the gearing employed requires to be exceptionally heavy. Breakages are frequent in all plantations of even the strongest machinery; often through carelessness or deliberate malice the machinery comes to grief. Negroes in the sugar-growing countries, when they wish a holiday, do not hesitate to drop a piece of iron or a steel chisel amongst the gearing, either breaking or greatly overstraining it. But even in the regular work of crushing the canes undue stresses are brought about by the careless distribution of the canes upon the carrier, causing irregular crushing at the mill. Should a few feet of the cane carrier be thinly supplied with canes, followed by a heavy bundle, the engine has time to race, and may then be suddenly brought to a standstill by a mass of canes altogether out of proportion to the spaces at which the rollers are set. The semi-crushed cane gets jammed between the rollers and the "dumb returner," effectually breaking the mill. The gearing also in shipment and transport is apt to meet with rough usage, hence the great necessity for excessive strength in the gearing and framework.

In calculating the strength of the gearing required to drive any given sugar mill, the empirical formulæ in use for ordinary gearing cannot well be applied with any certainty, nor does it correspond with the results obtained in practice. This is owing to the exceptional conditions under which the gearing for sugar mills is worked. In this class of gearing the velocity at the pitch line is low, and the stresses, as already explained, liable to be sudden and severe.

The thickness of the teeth for spur gearing depends on the pressure to be sustained, and this relation is conveniently expressed for most cases by the formula $T = C\sqrt{S}$; where T = thickness of tooth in inches, S = stress on teeth in lb., and C = a constant multiplier depending on the material. The value of C is usually found as follows:—Let A represent the known strength of a bar 1in. long and 1in. square; then to support a weight W by a bar of a length l and breadth b, the thickness T must be, according to the received formula for the strength of materials, in this relation:—

$$T = \sqrt{\frac{S \times l}{A \times b}}.$$

Now it is usual to assume that a portion

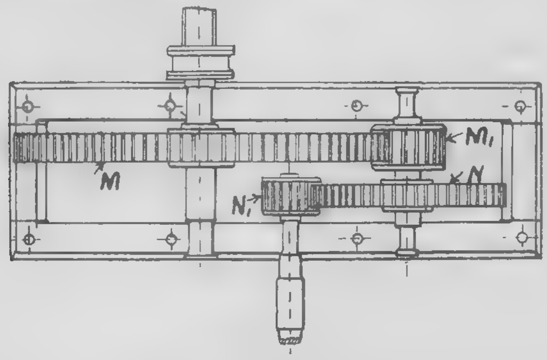
only of the breadth of the tooth equal to twice the length ought to be taken into account in the calculation, because, with common moulded wheels, the teeth are liable to fracture across the corners. (With wheel-moulded wheels, however, this hypothesis is not quite tenable, as it is possible to mould them so that they bear very evenly along their whole length, even in wheels of considerable breadth.) But on the above assumption we have $b = 2l$. Whence

$$T = \sqrt{\frac{S \times l}{A \times b}} = \sqrt{\frac{S \times l}{A \times 2l}} = \sqrt{\frac{S}{2A}}.$$

Taking A = 7000lb. for cast iron, we have 2 A = 14,000lb., estimated as dead load.

revolutions per minute = 15·8ft. of roller surface per minute. The ratio of the gearing will therefore require to be $= \frac{35}{2} = 17{\cdot}5$ to 1.

The gearing of sugar mills is usually composed of two sets of wheels, termed compound or double gear, arranged as per Fig. 78. The second-motion wheel in the example given we found would have to make two revolutions per minute; its diameter would require to be about 10ft. 10in., and the speed at the pitch line in feet per second would be $= \frac{34 \times 2}{60} = 1{\cdot}13$ft.



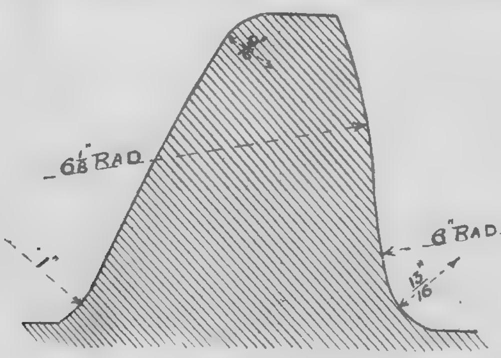
Sugar Machinery.—Fig. 78.

The factor of safety should in this case be at least 10 for gearing of this class subjected to great shocks. Assuming a factor of safety of 10, the practical value of 2 A may be taken at 1400, and accordingly

$$T = \sqrt{\frac{S}{2A}} = \sqrt{\frac{S}{1400}} = \frac{1}{38}\sqrt{S} \text{ nearly, or } = 0{\cdot}0263\sqrt{S}.$$

In steel wheels the value of A may be taken at from 2 to 3 times for cast iron, or, say, A = 21,000. Therefore, 2 A

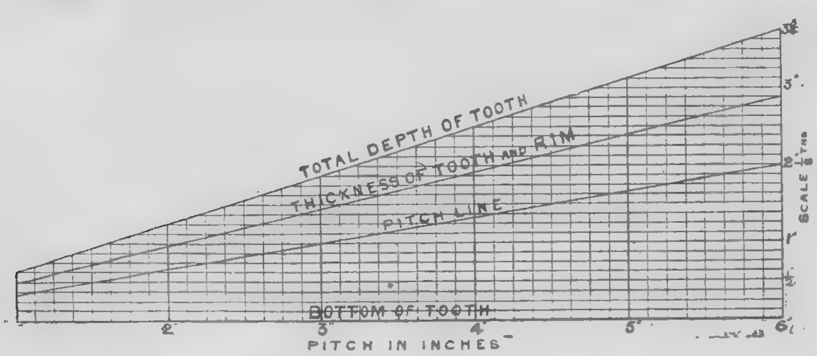
The stress at the pitch line will therefore be $\frac{550 \times 145}{1{\cdot}13} = 75{,}753$lb. By the formula already given, and allowing two teeth to be in gear at one time, $T = 0{\cdot}0263\sqrt{\frac{75{,}753}{2}} = 5{\cdot}1$in., say 5⅛in. thick, a result which is manifestly absurd. It is therefore more satisfactory for purposes of calculation to treat the teeth as cantilevers,



Sugar Machinery.—Fig. 79.

= 42,000, and taking the same factor of safety we have $T = \sqrt{\frac{S}{4200}} = \frac{1}{65}\sqrt{S} = 0{\cdot}0154\sqrt{S}$ for steel, and in the same way the value of C may be got for any other material. To obtain the stress acting at the pitch line of the wheel, multiply 550 by the horse-power (I.H.P.) the wheel has to transmit, and divide by the velocity at the pitch line in feet per second; the quotient will be the stress in lb. Suppose, as an example, we have a sugar mill having

and assume the stress to act as a dead load. With slow-running teeth this method of calculation will be found to give results more closely agreeing with those obtained in practice. In the case of spur wheels transmitting heavy loads at high velocities the effects of impact and vibration have to be considered, as they materially affect the life of the teeth, with the result that practically a much higher factor of safety has to be employed. Dealing with the example before us, let A = area of cylinder in square inches,



Sugar Machinery.—Fig. 80.

rollers 30in. diameter by 66in. long, driven by a horizontal engine having steam cylinders 20in. diameter by 48in. stroke, making 35 revolutions per minute, with a boiler pressure of 75lb. by the gauge, and a back pressure in the exhaust pipe of 10lb. per square inch. The mean effective pressure in the cylinder will be about 55lb., with the steam cut-off at ⅝ stroke, and a loss of 4lb. allowed between boiler and engine. The indicated horse-power available will therefore be $= \frac{314 \times 55 \times 280}{33{,}000} = 145$I.H.P.

The mill rollers will make about two

P = mean effective steam pressure in lb. per square inch, r = radius of crank in inches, N = number of teeth in first-motion wheel, M = number of teeth in second-motion wheel, N = number of teeth in the first-motion pinion, M_1 = number of teeth in second-motion pinion (see Fig. 78), S = stress on teeth in lb. at pitch line of M wheel, R = radius of second-motion (M) wheel in inches. Then $S = A \times P \times r \times \frac{N}{N_1} \times \frac{M}{M_1} \times \frac{1}{R}$.

Assuming in this instance that N = 66 teeth, M = 80 teeth, N = 17 teeth, and M_1 = 18 teeth. Then $S = 314 \times 55 \times 24 \times \frac{66}{17} \times \frac{88}{18} \times \frac{1}{65} = 120{,}199$lb. If T = thickness of tooth in inches, B = breadth of teeth in inches, and L = length of teeth in inches; then from the formula for the strength of rectangular beams we have S = safe load on one tooth $= \frac{T^2 \times B \times C}{L}$. C = constant, usually taken at 600 for ordinary gearing corresponding to a factor of safety of 10, but in gearing of this description it may be taken at 900 to allow for the effect of friction in reducing the actual stress on the teeth of the second-motion wheel. For wheels shrouded on both sides to the pitch line, C may be taken equal to 1200. Cast-steel wheels may be taken as two to three times stronger. Although the tensile strengths of the two metals are more nearly as four to one, steel wheels, owing to it not being possible to cast the teeth so accurate and sound, should not be considered more than twice the strength of good cast iron.

Applying the above formula to the example given, in wheels of this size it will be safe, as before, to assume that the load acts on two teeth at once, as at least that number will be in gear at one time.

The breadth of face we will assume at 13in., and the length of tooth at 2¾in. The required thickness of tooth will be

$$T = \sqrt{\frac{\frac{120{,}199}{2} \times 2{\cdot}75}{13 \times 1200}} = 3\tfrac{1}{4}\text{in.}$$

This gives a result somewhat higher than is used in practice, as in this wheel the pitch would be 4⅝in., width 13in., and the thickness of tooth at root about 2⅞in., which means that the factor of safety adopted in this case is less than we have assumed.

Helical wheels have not been much employed for the gearing of sugar mills, although there is no good reason why they should not, except their slightly higher cost and the risk of obtaining badly-made teeth. The sloped-back form of tooth might with advantage be more frequently employed, being no more expensive to make than ordinary teeth, while it is at least 50 per cent. stronger. Fig. 79 shows a tooth of this description. It will readily be seen that it must be greatly stronger than the ordinary form of tooth. The example shown is that used successfully on a large spur driving wheel transmitting 700H.P., with a pitch-line velocity of 2400ft. per minute. The pitch is 4·4in., the breadth 18in., and the teeth are flanged to the pitch line on both sides.

The length of the teeth varies with different makers. The majority of makers proportion the length of the teeth at ¾ of the pitch. It is gradually dawning on the intelligence of wheel makers that this is too long. A fair proportion of length of tooth is $\frac{6}{10}$ of the pitch, and it might even be reduced to one-half the pitch with good results. Fig. 80 is a diagram giving the lengths and thickness of teeth from 1in. pitch to 6in. pitch based on a total length of $\frac{6}{10}$ of the pitch, and a thickness = 0·48 of the pitch.

The various dimensions are measured from the base line. Thus, for a 6in. pitch the total length of tooth will be 3¾in., the thickness of tooth and rim 2⅞in., and from the bottom of the tooth to the pitch line 2in. The vertical division on the diagram represents ⅛th, and the horizontal division also ⅛th, although drawn double the former in width.

We may here in a comparative way illustrate the relative strengths of an ordinary tooth of a length equal to ¾ of the pitch, and a sloped-backed tooth of a length equal to $\frac{6}{10}$ of the pitch.

Taking the dimensions given in Fig. 79, and using the previous formula for an unshrouded tooth, we have for the plain tooth a length of about 3⅜in., and a thickness at the root of 3in. For the sloped-backed tooth the length would be 2⅝in., and the thickness at the root about 3⅜in. We have then safe load on plain tooth $= \frac{3 \times 3 \times 18 \times 900}{3{\cdot}37} = 43{,}264$lb.; and for the sloped-backed tooth $= \frac{3{\cdot}37 \times 3{\cdot}37 \times 18 \times 900}{2{\cdot}62} = 70{,}427$lb., or about 61 per cent. stronger.

(To be continued.)

The White Star Liner "Gigantic," which is being built by Messrs. Harland and Wolff, of Belfast, is the first vessel to exceed the "Great Eastern" in length. That vessel measured 680ft., and the "Gigantic" is 700ft. The "Great Eastern," however, excelled in breadth, having a beam of 83ft., whereas the "Gigantic" measures 68ft. The engines of the "Great Eastern" were 7650H.P., whilst those of the "Gigantic" are 45,000H.P.

The Mannesmann Process of Seamless Tube Rolling.

(Concluded from page 162.)

In Figs. 21 and 22 two blanks are rolled simultaneously, whilst in Figs. 23, 24, and 25 three or more blanks may be worked upon at the same time.

The machinery thus described is in operation at the Mannesmann's Tube Company's works, the power required to produce the

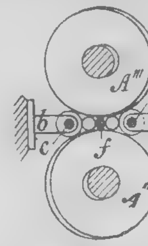


FIG. 21

tubes being very great, something like from 2000 to 10,000H.P., according to the dimensions of the tube. The whole of the power is not required at the same time, or a number of steam engines would have to be employed. This great power is only required for a very short time For each

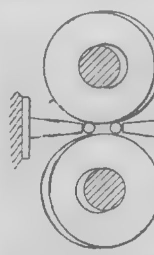
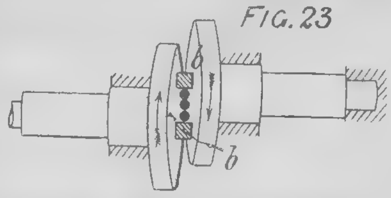


FIG. 22

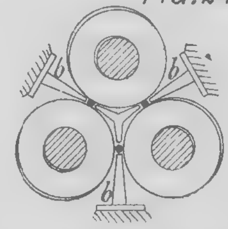
tube made, 30 to 45 seconds suffice to convert a bar 10ft. to 12ft. long, and 4in. in diameter, into a tube, and then some time elapses whilst the next bar is being brought up, adjusted in the guides, and the finished tube removed. During the lapse of time it is possible to accumulate energy in the fly-wheel, and by this means a comparatively

FIG. 23



small steam engine of about 1200H.P. is sufficient. A very large fly-wheel is a valuable aid in the production of power, the fly-wheel being of special construction, and designed specially to guard against bursting when working at a

FIG. 24



high speed. This wheel consists of a cast-iron hub, to which are securely bolted two discs of steel plates of about 20ft. in diameter. Around the periphery of the wheel thus formed about 70 tons of No. 5 gauge wire are wound under a tension of 50lb., thus binding the whole securely together. The fly-wheel is 20ft. in diameter, and weighing 70 tons, revolves 240 times per minute; therefore the periphery of the wheel has a speed of 2·85 miles per minute. Near the rolls are the doors of the heating furnace—a Siemens regenerative furnace heated by radiation, the only

FIG. 25

thing which distinguishes it being its great size. It is 33ft. long by 21ft. wide, and has an area of 789 sq. ft.

One of the many distinctive features of the Mannesmann process is the great accuracy required in adjustment of the rolls. Every part of the mill is adjusted and accurately fitted as in a locomotive

engine; the screws and balances are designed to enable the foreman roller to adjust the rolls to $\frac{1}{32}$in. The tubes, before leaving the works, are inspected and tested under compression.

What mainly distinguishes the tubes made by the Mannesmann process from all weldless tubes hitherto made is: First, that they are made from bars of solid steel or other metal into tubes without any preliminary boring of the material; and, secondly, that the fibre of the metal runs spirally round the tube when made.

The most severe test which the Mannesmann tubes can possibly be subjected to is the process of manufacture itself. If the metal is homogeneous throughout, and well melted, well rolled, and carefully heated, it makes a perfect tube, or, at any rate, a near approach to it; but if there is any flaw in the bar, or if the furnaceman has been careless in the heating, then the Mannesmann rolls reject the bar by refusing to make a tube of it more sternly than the severest human inspector would.

The Mannesmann tubes are capable of resisting much higher internal pressure in comparison to the thickness of their shells. Cast-iron pipes will hardly stand more than 200lb. per square inch, and welded tubes are not as a rule safe above 1000lb. per square inch, while the Mannesmann easily withstands 2000lb. per square inch.

At present there are five works making tubes by this process. First the parent works at Romsheid, in Rhenish Prussia, where all the early experiments were carried out; then another works in South Germany, at Boas; the Austrian works at Komstan; works at Duisburg; and lastly, the works at Landore, near Swansea.

In conclusion, I hope I have made this difficult process understood. It is like a conjuring trick; it looks very simple when one can see it done, but it is a very difficult thing to say how it was done. It is undoubtedly the outcome of the tube-making processes, and it is extraordinary to reflect the comparative excellence to which this branch of industry has developed.

The paper was illustrated by limelight views, and was followed by a discussion, in which Messrs. J. H. Richards, E. C. R. Marks, S. S. Mark Muirhead, and H. M. Waynforth took part. The proceedings terminated in a vote of thanks to the author for his paper.

Improved Leclanché Batteries, Etc.

The Leclanché battery is now so universally used that it is scarcely necessary to mention that, in its simple form, it consists of a mixture of carbon and peroxide of manganese, forming the positive element, and a zinc plate or rod for the negative element, both being immersed in a saturated ammoniacal solution. Since the earliest form of this battery was patented in 1866, several improvements have been effected which have increased both its efficiency and durability. The agglomerate block type of cell, patented in 1873 and 1878, marked a distinct step in advance; but a still greater improvement was effected in 1886, by the introduction of the Leclanché-Barbier battery. This latter type, which, although it has long been in use on the Continent, has only recently been introduced into this country, is shown in the accompanying illustrations. Fig. 1: The positive element of this cell consists of a hollow cylindrical agglomerate block of carbon and peroxide of manganese, round the upper edge of which there is cast on a metal ring or collar carrying a binding screw. The same end of the cylinder is closed by a paraffined wooden stopper, having a hole in its centre just sufficiently large to allow the zinc rod—which forms the negative element—to fit tightly into it. The zinc is thus held truly in the centre of the cylinder, and it has on its lower end a band of indiarubber to prevent any accidental contact between it and the agglomerate. The two elements are immersed in the ammoniacal solution contained in a glass jar. When the cylinder is in its place the metal ring round its upper edge rests on the edge of the mouth of the glass jar. The cylinder and zinc are of such a length that they both remain suspended in the liquid without touching the bottom of the glass jar, and an indiarubber washer interposes between the metal ring on the cylinder and the ground edge of the mouth of the jar. The weight of the cylinder thus automatically and hermetically closes the joint between the two. This cell is, therefore, a closed one, and there is no evaporation of the ammoniacal solution, to the complete suppression of creeping salts, which are so troublesome in the other forms of Leclanché's cells.

Fig. 1. Leclanche Batteries, etc. Fig. 2

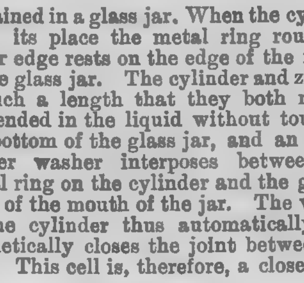


Fig. 3.

In Fig. 2 is shown the Leclanché-Barbier agglomerate dry battery, which fully equals the wet cell of corresponding size both in electrical output and durability. The cell consists of a Leclanché-Barbier hollow cylindrical agglomerate, cemented into an outer zinc case by a composition which in itself contains the ammoniacal solution. This composition hardens sufficiently to prevent any contact between the agglomerate cylinder and the zinc casing, but it always retains a certain degree of dampness. The orifice of the cylinder is closed by a wooden stopper to prevent undue evaporation from the interior. The advantages claimed for these cells are:—The peroxide is employed in the manner most favourable to its complete reduction, ensuring constancy and better depolarisation than in the older forms; the position of the zinc conduces to durability, the cell is hermetically sealed, decrease in internal resistance, etc. The dry cell has the further obvious advantages over the wet form:—The absence of all liquids allows of its use when the employment of ordinary cells would not be possible, or at least very difficult, inconvenient and costly; it is supplied ready for immediate use; it will work efficiently in any position, while it occupies much less space than a wet battery of equal power. Further, when its electrical force is diminished it can be immediately restored to its full power by resaturating with ammoniacal solution.

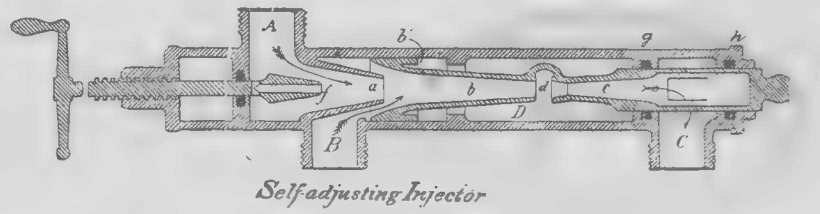
In Fig. 3 a new form of electric bell is illustrated. It is constructed entirely of metal, and is therefore both strong and durable. This bell rings easily and regularly with a single cell, and it is supplied at an exceedingly low price. As will be seen, the play of the armature can be readily adjusted. The bell is well finished, the gong and terminals being nickel-plated. Mr. R. Aylmer, 47, Victoria-street, Westminster, London, S.W., who is the sole concessionnaire for the Leclanché battery, will supply any further particulars desired.

Notes on the Steam Injector.

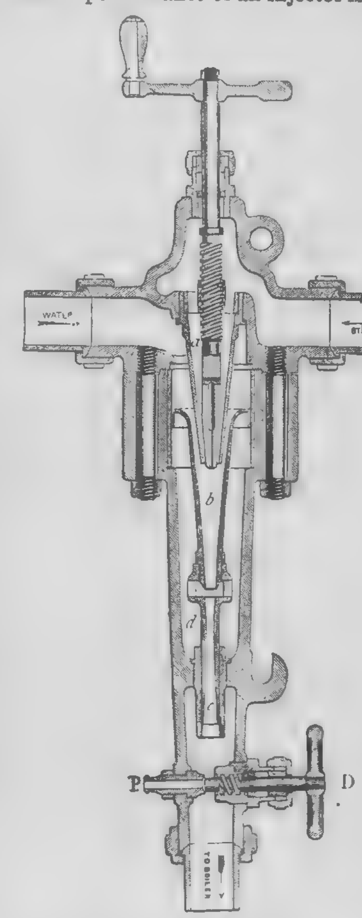
(*Continued from page* 108.)

As the constructive defects of the injector were obvious, the first changes introduced were improvements in the packing of the steam ram, and those manufactured in this country in 1860 were provided with a conical stuffing-box filled with a number of split rings made of metal softer than the body, but unequal wear upon the ram soon caused leakage with this system also. It is singular that the merits of the fixed nozzle injector were not earlier appreciated. Millholland, of Reading, Pa., patented in 1862 an injector formed of non-adjustable tubes, depending upon the use of external valves for regulation; but this met with no success, and does not appear to have ever gained publicity. Internal adjustments seem to have been regarded as all-important, for the early Giffard injectors were not provided with check valves upon the overflow, and any reduction of the water supply would cause considerable indraught of air to the boiler unless counteracted by corresponding reduction in the steam discharge. The avoidance of the check valve may have been intentional, and due to the weak form of lifting jet employed, as the power of suction was affected by the slightest increase in resistance to the free discharge of the steam. Subsequently fixed nozzle injectors came into extensive use, and are now applied to many kinds of service.

As the problem of successfully packing the steam ram seemed impossible of solution, Robinson and Gresham, of Manchester, attempted in 1864 the plan of regulating the water area by moving the combining and delivery tubes toward or from a fixed steam nozzle. A pinion meshing into a rack cut upon the exterior of the tube was actuated by a hand wheel on the body, and a long cylindrical bearing upon the outside of the delivery tube prevented any serious leak from the boiler pipe. A similar device was introduced in 1868 by Samuel Rue, of Philadelphia, who applied stuffing-boxes to the ends of each tube, and regulated their position by means of a hand lever. The fundamental problem was, however, to make the adjustments of the water supply automatic, and eliminate as far as possible the necessity for watchful care on the part of the engineer. Giffard had already described in his patent specification two methods by which this could be obtained—one by placing a spring behind a movable steam nozzle in such a manner that an increase of pressure would cause compression of the spring and elongate the distance between the tubes, while the resilience of the spring would regulate properly for a converse condition. This was never put into practical operation, and it is easy to see difficulties that would discourage the attempt. The other suggestion was to vary the pressure of the entering water by subdividing the steam jet and using the first or subsidiary apparatus for feeding the second or forcing set of tubes under a pressure that would vary in proportion to the requirements. A still simpler method was that invented by William Sellers, of Philadelphia, in August, 1865, by which any change in the internal condition of the jet would actuate a set of movable tubes so that the correct proportion of the water to the steam would always be obtained. Ever since the introduction of the injector the advantage of an automatic adjustment was realised, and a series of experiments had been carried on by William Sellers and Co. for the purpose of attaining this end. After numerous experimental devices had been thrown aside, the injector shown in section in Fig. 2 was tested and found to work satisfactorily. The basis of the invention was the discovery of the strong vacuum produced by the moving jet in a closed overflow chamber when the water supply was reduced below the maximum, and that an excess of feed-water would cause the pressure in a confined overflow chamber to rise above that of the atmosphere before the jet would break. Now, as the most efficient performance of an injector is when the pressure of the jet while crossing the overflow is the same as that of the atmosphere, indicating that the density is approximately unity and that the steam is entirely condensed, it only remained to compel the condition of the overflow to influence the water entrance to the combining tube. Any variation of the steam and water supply would then first affect the absolute pressure in the overflow chamber, and this would immediately respond upon the water admission by a proper movement of the combining tube.



Steam Injector.—Fig. 2.



Steam Injector.—Fig. 3.

Fig. 2 gives a sectional view of one of the earliest experimental forms of this device, with constructive details intentionally omitted. Steam, feed, and the boiler connection are indicated by the letters A, B, and C, and the steam nozzle, combining tube and delivery tube by *a*, *b*, and *c*. D is a closed overflow chamber, communicating with the interior of the tubes through the overflow *d*, situated slightly above the minimum diameter of the bore of the tube. The delivery tube *c* passes completely through the delivery chamber C, and is packed by stuffing-boxes *g* and *h* of equal diameter, and is therefore balanced with reference to any pressure

carried in the boiler, so that the tubes are free to move under the influence of any pressure within the chamber D, acting upon the differential areas of the piston b' and outside of the delivery tube c. As discharge from the overflow chamber was not permitted, the injector was started by means of a valve placed in the boiler branch C, not shown in the illustration. Two years later it was discovered that the pressure in D was strong enough to obviate the use of the balanced delivery tube, and the simpler form shown in Fig. 3 was devised. It could be placed in any position, horizontally or vertically, as gravity had no appreciable effect upon its action. Using the same nomenclature as before, a is the steam nozzle, b the combining tube, and c the delivery tube. The operation was as follows:—The starting valve D, placed below the delivery tube, was opened, and free discharge given for the lifting steam jet, issuing from a small hole drilled in the steam spindle. This gave a strong suction vastly superior to the lifting power of the original Giffard injector, and being in excess of the requirements of the ordinary height of lift, produced a lower pressure in the closed chamber d than in the feed-pipe. The combining tube would therefore move down to the lower part of its stroke, exposing full admission area for the water, until the rising of the water and condensation of the issuing steam jet caused a nearly perfect vacuum, which drew the tube to the other end of its stroke. As the spindle was drawn slowly back, the proportion of steam became too great for immediate condensation, and the contraction of the jet continued while crossing the overflow. The ensuing vacuum in the overflow chamber, acting upon the piston head of the combining tube, drew the tube away from the steam nozzle, admitting an increased supply of water. It is thus seen that regulation occurs with any change in the steam supply, whether that change be produced by a variation of the pressure of the boiler or of the effective area of the steam nozzle. When the spindle is drawn fully back the starting valve D is closed and the feeding of the boiler established. It follows, therefore, that a reduction in capacity of the injector may be effected by running the spindle part way down into the steam nozzle, and the water supply will be automatically reduced in proportion. At any fixed steam pressure the temperature of the water delivered to the boiler will be nearly the same for both the maximum and minimum capacity. A change in the height of lift would diminish the quantity of feed-water until a downward motion of the combining tube, due to the increased vacuum in the closed overflow chamber, would compensate by increased area the loss of velocity due to the reduction in the difference of pressure between the interior of the combining tube and the height of the lift. This method of regulation gives exceedingly good results over a wide range of pressure, and with an expenditure of steam that is proportional to the work performed.

From an inspection of Fig. 3 it will be seen that the performance of the injector depends upon the tightness of the joint between the delivery tube b and its sleeve bearing, just as the original form relied upon the packing of the adjustable steam nozzle. Unequal wear of this part permitted leakage between the boiler and the overflow chamber, although not as rapidly nor to so fatal an extent as in the former case.

This led to the application of the discovery previously made by Gresham, that the overflow space between the combining and delivery tubes could be lengthened without materially affecting the efficiency, and in 1873 this form of injector was still further improved by separating the combining tube from the delivery tube, screwing the latter into the body, and permitting the combining tube free movement toward and from the steam nozzle. This altered the length of the overflow space with every change in the position of the tube. With low pressure the combining tube was drawn close to the steam nozzle, exposing the maximum length of overflow space. As the pressure rose this distance was reduced, and the length of the overflow at the higher pressure was less than that used in the older form of injector. The principle and development of this invention has been explained in detail on account of its merit and originality. In an improved and modified form this injector is extensively used at the present time, and still preserves the peculiar principle that made it such an advance over the earlier instruments employed.

The other method of automatically regulating the water supply, by subdividing the actuating steam jet, was introduced in the United States in 1876, when two American patents were issued—one to Ernest Körting, of Hanover, Prussia, and the other to John Hancock, of Boston. Foreign patents had already been granted to the former, who had been a manufacturer and experimenter for many years. The devices were practically alike. The invention consisted in combining two sets of tubes, and each set was proportioned to the function it had to perform. A small steam nozzle discharged into a large combining tube, which delivered the feed-water under a slight pressure to the entrance of the smaller combining tube of the forcing set, where, meeting the steam issuing from a larger nozzle, the water received an additional impulse sufficient to force it into the boiler. The increase in feeding capacity of the first set of tubes with the rise in the steam pressure obviated the necessity for any regulation of the water supply to allow for fluctuation in the pressure carried in the boiler.

(*To be continued.*)

Society of Engineers.

At a meeting of the Society of Engineers, held at the Town Hall, Westminster, on Monday evening, 1st inst., Mr. W. A. McIntosh Valon, J.P. (President), in the chair, a paper by Mr. Edmund Burrows, on Blake's Bridge, Reading, was read. This bridge crosses the river Kennet, and unites the north and south sides of the borough. The old bridge was erected in 1855, with a carriage road only 14ft. wide. Proving too narrow for the increase of traffic, it has been removed, and a new bridge, 30ft. wide, has been erected by the Corporation in its place. The new bridge of 51ft. 4in. span was designed by Mr. A. T. Walmisley, M. Inst. C.E., and consists of lattice girders 4ft. 6in. deep, having parallel flanges with ornamental cast-iron work between the diagonal members, so fixed as to provide a parapet without interfering with the definite transmission of strain throughout the braced members of the structure, which is constructed of mild steel. With the view of distributing the live load produced by a steam roller of 15 tons, together with a distributed weight over the remainder of the platform estimated at 1cwt. per foot, super., trough flooring 5in. deep is used, having the lines of ridge and furrow fixed at right angles to transverse lattice girders 4ft. 6in. apart, suspended from the main girders, but stiffened in their attachments at the ends by side brackets. The girder form of construction was adopted as providing uniform headway under the bridge, while the original level of the approaches and roadway over the bridge was not raised. With the view of employing the abutment walls of the old bridge, the new girders were carried on brick piers supported by pile foundations, and surmounted with ornamental masonry caps. The upper flange of each of the main girders is covered with American oak to form a handrail. The bridge was tested after completion by loading with water-vans a 10-ton steam roller, and loaded stone trolleys, in all amounting to a total load of 63½ tons distributed, and gave a deflection in the centre of $\frac{3}{16}$in. The bridge was opened for public traffic on October 6, 1892. During construction, vehicular traffic was only impeded for about two and a half months. Messrs. Parker and Co. were the contractors for the foundations and masonry, and Messrs. Handyside and Co., of Derby, for the erection of the steel and iron work. The total cost of the bridge and improved approaches was £4500. The author acted as resident engineer for the Reading Corporation during construction.

Scotch Shipbuilding in April.

The shipbuilding returns for April show that the condition of the industry in Scotland is serious in the extreme. The work which builders are prepared to begin is now very much less than it was at the commencement of the year, and the chances of an immediate improvement are, taking one consideration with another, decidedly fewer. The month has seen the completion on the Clyde of the two fastest steamers in the world. Each was intended to be in its class the fastest afloat, and both have on trial realised the expectations of their builders. On a trial of exceptional severity, the "Leopold II.," a paddle steamer which Messrs. William Denny and Brothers have constructed for the Belgian Government's trans-Channel mail service, attained a speed of 22.16 knots, earning by her behaviour unlimited glory, and, what was of more account, a large premium for her builders. The first of the two Cunarders did even better, exceeding the contract speed on her official trial by almost a knot. Messrs. William Denny and Brothers are to build a steamer of 5000 tons deadweight for Messrs. P. Henderson and Co., Glasgow, and two small steamers for Russian owners. A steel sailing ship of the ordinary type has also, it is stated, been ordered from an establishment in the vicinity. Messrs. Murdoch and Murray, Port-Glasgow, are to build a screw steamer 150ft. in length for Messrs. R. B. Ballantyne and Co., Glasgow, and a twin-screw steamer like the three they constructed recently for passenger service on the Amazon. Two screw steamers are to be built by the Ailsa Shipbuilding Company, Troon—one for Messrs. Shepherd and Co., Bombay, and the other for Liverpool owners. Messrs. Gourlay Brothers and Co., Dundee, are to build a steamer of 600 tons for an Austrian line carrying passengers and mails in the Adriatic. A paddle steamer 145ft. long is to be constructed by Messrs. Scott and Co., Greenock, for a French firm; a screw lighter 67ft. long by Messrs. D. M. Cumming and Co., Blackhill Dock, for Liverpool owners; and a tug steamer, similar to one on hand, by Mr. John Gilmour, Irvine. Messrs. Robert Duncan and Co., Port-Glasgow, have contracted to build a sailing ship of 2850 tons carrying capacity.

During the month Scotch shipbuilders launched 22 vessels of 20,670 tons, of which 15, representing 14,585 tons, were steamers, and seven, measuring 6085 tons, sailing vessels. To the total the Clyde contributed 14 steamers of 10,685 tons, and seven sailing ships of 6085 tons, and the Tay a steamer of 3900 tons. The total is much below that of last month, and the aggregate less by nearly one-half than in 1892.

The Lowest Temperature.

While M. Moissan has devoted himself to obtaining high temperatures, and has obtained heat rising to thousands of degrees, M. Raoul Pictet has been carrying on a series of experiments in the opposite direction. By steps carefully reasoned out he has succeeded in obtaining a temperature lower than any hitherto known—273° C. below zero, or 491° F. below the freezing point of water. M. Pictet obtained this temperature by using a series of cold wells which brought him gradually to the final result. In his first well he used a mixture of carbonic acid and sulphurous acid, and by their evaporation obtained a temperature of 110° C. below zero. In this first cold well he immersed a condenser in which the vapours of a still more volatile liquid—protoxide of nitrogen or ethylene—were condensed, and thus reached 150° below zero. In the third well he reached 210°, and in a fourth 273°, beyond which he has not yet gone. In his third and fourth wells nitrogen, carbonic oxide, marsh gas, and atmospheric air under a pressure of 40 atmospheres were used. M. Pictet has communicated some of the results he obtained to the Société des Sciences Naturelles at Geneva, but has not yet given full accounts. The instruments with which the lower temperatures were measured were hydrogen thermometers graduated by comparison with sulphuric-ether instruments.

Among the other results obtained, M. Pictet has been able to reduce atmospheric air to a liquid state, in which it showed a blue colour. He has obtained alcohol, ether, bromide of ethyl and chloroform in an absolutely pure state. The low temperatures given will, he believes, open some new views of chemical combination, and enable him to obtain some hitherto unexpected results, and possibly some changes in industrial processes. He is at present engaged in investigating the question of the temperature necessary to extinguish life entirely in certain classes of microbes.

It is interesting to note that these experiments have developed enormous pressures, and that M. Pictet's cold wells might be converted into dangerous projectiles. It may also be noted that while, at the temperature of 6000° above zero obtained by M. Moissan, the earth would be burned up or vaporised, the 273° below zero which M. Pictet obtained would be followed by absolute death, and it is doubtful whether even the more solid portions of the globe, the rocks and stones, could retain their form. Certainly no form of organic life with which we are acquainted could continue to exist.—"Le Génie Civil."

On the 27th ult. Messrs. R. Napier and Sons launched from their shipyard at Govan a steel screw steamer. Her dimensions are:—Length of keel and forerake, 230ft.; breadth, 32ft.; depth of hold from main deck, 14ft. 10in. She will be fitted with a set of triple-expansion engines, with two boilers for a working pressure of 165lb.

Applications of Electricity to Chemistry.

In a recent lecture on this subject at the Royal Institution, Mr. James Swinburne directed the attention of his audience to the subject of tanning by electricity. The ordinary processes of tanning, by which the hide was converted into leather, was so slow that various inventors had endeavoured to accelerate them. The first real improvement took place when mechanical motion was employed for the purpose of obtaining a continually fresh application of the tanning liquor to the surface of the leather. From 1849 and onwards, various attempts were made to apply electrical methods to the tanning system, and we had now a process, of which Mr. Lorentz A. Groth was the inventor, which enormously lightened the labours of those employed in tanning. His process was a combination of mechanical motion and electrical treatment, the electrodes, consisting of strips of copper, being placed against the sides of the vat. The lecturer directed attention to a diagram of complete tannage by Groth's system, by which the daily absorption of tannin from the liquor was shown during the period of one month. Mr. Swinburne said he would now turn to another subject—the electrolysis of fused salts,—and he hoped to be able to show some experiments on this subject, but he must remind his audience that the laws of Nature did not hold good in the Royal Institution, and his experiments might be interfered with by exterior agents. What did we mean when we spoke of "ordinary temperature"? There are some things which we called solid which in other quarters of the globe were liquid; and, *vice versa*, things which we know as liquids were solids elsewhere. We knew, for instance, that the composition of the atmosphere varied in low temperatures. Several experiments were now shown of the electrolysis of fused salts—tin chloride, antimony chloride, sodium chloride, lithium chloride, magnesium chloride, calcium chloride, amongst others, being made subjects for experiments. Speaking of the deposition of aluminium, the lecturer said that many people were of opinion that aluminium could not be deposited by the aid of a separate electric current, but we know now that this opinion was not correct, as various experiments had shown that aluminium could be deposited electrically. Glass was one of the best, if not the best, insulator we possessed, and it could be shown that the electrolysis of glass was quite as easy as the electrolysis of anything else. Ozone can be developed by electrolysis in aqueous solutions of nitric, sulphuric, or phosphoric acids. To show the manufacture of ozone high pressure was required, and also a special plant. The lecturer said he must, therefore, content himself with explaining the principle of its manufacture.

Shipbuilding Notes.

The official trials have taken place at Ostend of the mail steamer "Leopold II.," built by Messrs. Wm. Denny and Bros., Leven Shipyard, Dumbarton, to the order of the Belgian Government. On the trial a mean speed of 22 knots was attained.

Messrs. Wm. Gray and Co. Limited launched from their Central yard, West Hartlepool, on the 29th ult., the steel steamer "Penarth." She is 335ft. in length, 42½ft. breadth, and 23½ft. depth. Her triple-expansion engines, of 1200H.P., will be supplied from the builders' Central Marine Works, with steel boilers having a pressure of 160lb.

On the 22nd ult., the screw steamer "Hong Kong," built by the Sunderland Shipbuilding Company Limited, was taken out to sea on her trial trip. The vessel is 240ft. by 32ft. by 19ft. 6in. The engines were made by the North-Eastern Marine Engineering Company Limited, Sunderland, and have cylinders 20in., 34in., and 56in. diameter by 36in. stroke. The mean speed obtained upon this run was 12¼ knots per hour.

The "Ramilies," a first-class battleship of the "Royal Sovereign" type, which was recently received from the Clyde, where it was built and engined by Messrs. Thomson, made an eight hours contractors' trial of her engines, at Portsmouth, on the 25th ult., under natural draught. The ship was designed for a mean load draught of 27ft. 6in., and her mean immersion on trial was 25ft. 2in. The average steam in boilers was 149lb., which was maintained with the remarkably low air-pressure of 0·22in. The vacuum was very good, averaging 27·8in., and the port and starboard engines were worked regularly at 96·7 revolutions. Under these conditions the engines developed 4705 and 4710 horses respectively, thereby securing a collective indicated power of 9415 and a log speed of 16·75 knots. The designer's estimate was 9000H.P. and a 16-knot speed. The coal consumption during the run was 1·7lb. per unit of horsepower per hour, which was much below the average.

Principles, Possibilities, Curiosities and Limitations of the Crank Motion.—IV.

We come now to the pitman connection, concerning which it may be said that its possibilities and limitations are not yet fully defined. This is evident from the fact that as late as within two or three years an interesting modification of this movement has been made the subject of a patent granted to Messrs. Fleming and Ferguson, of Paisley, whereby two pistons are made to impel a single crank in a manner hitherto unattained; that is to say, the pistons are both connected with their common crank by a single connecting rod, and in such manner that there is no dead point.

Before extending this discussion, it is proper to recall a fundamental principle of analytical mechanics—to wit, that *power* is neither lost nor gained absolutely by any means or appliance used for transmitting it. The same is true of *work* and of *force or energy*, of which latter it is now known that there is conserved in nature a constant quantity, in various forms, potential, and actual; and that all the manifestations of force are due to changes from one mode or condition of energy to another or others. In most cases the transformation is multiform; that is to say, if mechanical power be expended, it is not all applied to the performance of useful work. A part—in many instances a large part—is absorbed by various resistances, such as friction, abrasion, etc., constituting unavoidable losses of power *as applied to some desired specific purpose*; but in the true philosophic meaning of the terms there has been neither loss nor gain. The power expended is all accounted for in the sum of the useful work performed and the several parts or quantities of the power consumed by the "*passive resistances*," the latter being a very concise and expressive term for which we are, I believe, indebted to the French school of physicists.

This being premised and thoroughly comprehended, we shall not only be amply guarded against entertaining the idea of the possibility of a self-moving machine, otherwise called perpetual motion—that *ignis fatuus* that has led so many astray,—but we shall avoid the notion that any modification of a pitman connection or any substitute for it can result absolutely in either loss or gain of power generated by steam against a piston or pistons connected to one crankshaft.

There may be a greater or less quantity of such power applied to the desirable or useful purpose of turning the crankshaft. This being admitted, as well as the prior proposition, the question of utility resolves itself into the questions of how much of the mechanical power generated by the movement of a piston is, by any such modification or substitute, absorbed through passive resistances between the piston and the crankpin; and, also, whether such modification or substitute is mechanical in its construction, so that without undue first cost it will endure for a reasonable period of time the necessary wear, and not exact too much care in adjustment, lubrication, etc., from the attendant during actual service? From and upon this basis our discussion will proceed.

Upon the supposition that steam follows the piston at full pressure during the entire stroke—a practice once common, but now nearly or quite obsolete,—the simple modification of the pitman, by increasing or diminishing the radius of the crank in proportion to the radius of the pitman, or, in other words, the length of the pitman measured from the centre of the crosshead pin to the centre of the crankpin, in proportion to the length of the crank measured from the centre of the crankshaft to the centre of the crankpin, causes a notable difference in the consumption of power through friction of the slides.

Table II. is designed to afford some useful data relative to the crank and pitman movement. It has been a rather laborious task to prepare it. A portion of this table has already been published, but as here presented it has been much extended to include much shorter lengths of connecting rods, in proportion to crank lengths. The headings give all needful explanations of the contents. The uses to which this table can be put will be obvious to engineers and draughtsmen.

Inspection of the table substantiates the proposition previously given that the mean rotative effort is greater during the first half of the out-stroke and during the last half of the in-stroke. Compare also the distribution of rotative efforts with long and short connecting rods. As the piston positions given are only for tenths of the stroke, it may be needful to find rotative effort for intermediate positions. This can be done approximately and with sufficient accuracy for most purposes for all positions between position 0·10 and 0·90 by taking the difference between consecutive rotative efforts in the column of rotative efforts and adding to the lesser rotative effort, or subtracting from the greater such a portion of this difference as corresponds to the difference of piston position.

Example.—With a piston position of 0·85, what will be the coefficient of rotative effort, when the connecting-rod radius is 3·5 times the crank radius? The column of coefficients for rotative effort

TABLE II. (*A.*)

Crank Angles, Rod Angles, Coefficients of Rotative Effort, and Coefficients of Pressure on Slide for Connecting Rods of Different Lengths Measured by the Crank Length Considered as Unit of Measurement.

Piston Positions Expressed in Fractions of Out-stroke.	Crank Radius / Rod Radius = 1				Crank Radius / Rod Radius = 8/9				Crank Radius / Rod Radius = 2/3				Piston Positions Expressed in Fractions of In-stroke.
	1	2	3	4	5	6	7	8	9	10	11	12	
	Crank Angles.	Rod Angles.	Coefficients of Rotative Effort.	Coefficients of Pressure on Slides.	Crank Angles.	Rod Angles.	Coefficients of Rotative Effort.	Coefficients of Pressure on Slides.	Crank Angles.	Rod Angles.	Coefficients of Rotative Effort.	Coefficients of Pressure on Slides.	
0·05	18° 12′	18° 12′	0·625	0·329	17° 56′	15° 53′	0·579	0·285	20° 2′	13° 12′	0·563	0·235	0·95
0·10	25 50	25 50	0·872	0·484	26 40	23 23	0·600	0·432	28 34	18 35	0·774	0·336	0·90
0·20	36 52	36 52	1·200	0·749	38 14	33 23	1·142	0·659	41 14	26 24	1·028	0·496	0·80
0·30	45 34	45 34	1·428	1·102	47 30	39 17	1·309	0·818	51 36	31 55	1·163	0·607	0·70
0·40	53 18	53 18	1·604	1·347	55 58	47 27	1·361	1·089	61 10	35 17	1·222	0·708	0·60
0·50	60	60	1·731	1·732	63 36	52 46	1·481	1·316	70 32	39 30	1·214	0·824	0·50
0·60	66 26	66 26	1·833	2·203	71 24	57 24	1·341	1·566	80 16	41 40	1·134	0·839	0·40
0·70	72 32	72 32	1·908	3·149	79 40	60 59	1·329	1·803	90	42 25	1·000	0·914	0·30
0·80	78 28	78 28	1·960	4·901	89 28	62 43	1·180	1·939	101 32	41 23	0·806	0·881	0·20
0·90	84 16	84 16	1·990	9·960	104 16	59 29	0·551	1·695	122 52	34 31	0·471	0·687	0·10
0·95	87 18	87 18	1·997	21·098	118 32	51 21	0·281	1·250	137 54	26 53	0·309	0·506	0·05

TABLE II.—(*Continued.*) (*B.*)

	Crank Radius / Rod Radius = 1/2				Crank Radius / Rod Radius = 2/5				Crank Radius / Rod Radius = 1/3				
	13	14	15	16	17	18	19	20	21	22	23	24	
0·05	21° 18′	10° 28′	0·453	0·185	21° 54′	8° 35′	0·513	0·151	22° 54′	6° 24′	0·453	0·112	0·95
0·10	30 12	14 34	0·728	0·260	31 18	12	0·701	0·203	32 4	8 54	0·674	0·157	0·90
0·20	43 42	20 13	0·957	0·368	45 18	16 31	0·919	0·297	46 28	12 4	0·877	0·214	0·80
0·30	54 54	24 8	1·076	0·448	57	19 36	1·033	0·356	50	14 10	0·987	0·252	0·70
0·40	65 18	27 1	1·122	0·509	67 48	21 44	1·077	0·399	70	15 31	1·035	0·278	0·60
0·50	76 12	29 3	1·104	0·548	78 28	23 4	1·065	0·426	81 45	16 25	1·023	0·294	0·50
0·60	86 10	29 55	1·036	0·575	89 30	23 35	1·004	0·4[illegible]7	92 15	16 35	0·988	0·298	0·40
0·70	97 58	29 41	0·911	0·570	101 32	23 4	0·895	0·426	104 30	16 30	0·896	0·296	0·30
0·80	111 48	27 40	0·724	0·5[illegible]4	115 34	21 9	0·691	0·387	119	14 28	0·749	0·257	0·20
0·90	120 32	25 31	0·619	0·477	127 18	18 34	0·591	0·326	136 15	11 24	0·546	0·202	0·10
0·95	145 34	16 25	0·322	0·296	147 12	12 32	0·355	0·222	148 44	8 16	0·342	0·145	0·05

TABLE II.—(*Continued.*) (*C.*)

	Crank Radius / Rod Radius = 1/3·5				Crank Radius / Rod Radius = 1/4				Crank Radius / Rod Radius = 1/4·5				
	25	26	27	28	29	30	31	32	33	34	35	36	
0·05	22° 54′	6° 24′	0·453	0·112	23° 10′	6° 38′	0·565	0·116	23° 25′	5° 4′	0·478	0·088	0·95
0·10	32 45	8 54	0·674	0·157	33 12	7 56	0·668	0·139	33 15	7	0·650	0·123	0·90
0·20	47	12 4	0·877	0·214	47 35	10 38	0·865	0·188	48	9 30	0·855	0·167	0·80
0·30	59	14 10	0·987	0·252	59 30	12 26	0·974	0·220	61	11 9	0·970	0·197	0·70
0·40	70	15 34	1·035	0·279	71	13 40	1·024	0·243	71 45	12 11	1·017	0·216	0·60
0·50	81 15	16 25	1·023	0·295	82 30	14 21	1·020	0·256	83 30	12 45	1·019	0·226	0·50
0·60	92 30	16 35	0·988	0·298	94	14 26	0·978	0·257	95 30	12 47	0·974	0·227	0·40
0·70	104 30	16 30	0·896	0·296	106	13 54	0·878	0·247	107	12 16	0·873	0·217	0·30
0·80	119	14 28	0·749	0·258	119 30	12 34	0·761	0·228	121 15	11 4	0·750	0·196	0·20
0·90	136 15	11 24	0·546	0·202	138	9 38	0·533	0·170	139	8 23	0·545	0·147	0·10
0·95	148 54	8 16	0·342	0·145	150 24	7 21	0·391	0·123	150 52	6 12	0·391	0·109	0·05

TABLE II.—(*Completed.*) (*D.*)

	Crank Radius / Rod Radius = 1/5				Crank Radius / Rod Radius = 1/5·5				Crank Radius / Rod Radius = 1/6				
	37	38	39	40	41	42	43	44	45	46	47	48	
0·05	23° 30′	4° 34′	0·472	0·080	23° 58′	4° 14′	0·474	0·074	23° 45′	3° 52′	0·464	0·068	0·95
0·10	33 30	6 20	0·651	0·111	33 40	5 47	0·646	0·101	33 50	5 17	0·633	0·192	0·90
0·20	48 30	8 36	0·849	0·151	49	7 53	0·843	0·138	50 15	7 23	0·841	0·130	0·80
0·30	61 15	10 7	0·966	0·178	62	9 14	0·962	0·163	62 30	8 30	0·956	0·149	0·70
0·40	73 30	11 3	1·014	0·195	74 15	10 5	1·011	0·176	74 45	9 15	1·007	0·163	0·60
0·50	84 30	11 29	1·015	0·203	85	10 26	1·012	0·184	85 30	9 34	1·010	0·169	0·50
0·60	96 15	11 28	0·972	0·203	96 30	10 24	0·971	0·184	96 45	9 32	0·970	0·168	0·40
0·70	107 15	11 1	0·867	0·195	107 45	9 58	0·874	0·176	108 15	9 6	0·861	0·160	0·30
0·80	121 15	9 50	0·761	0·173	121 30	8 55	0·764	0·157	123	8 2	0·762	0·141	0·20
0·90	139 15	7 30	0·553	0·132	139 30	6 47	0·551	0·119	139 30	6 13	0·567	0·109	0·10
0·95	151 16	5 36	0·402	0·098	151 44	4 58	0·409	0·087	151 51	4 30	0·402	0·079	0·05

when our crank radius divided by rod radius is $\frac{1}{3\cdot5}$ gives the coefficient 0·749 for position 0·80; and coefficient 0·546 for position 0·90. The difference is 0·203. As a position of 0·85 is more than the position of 0·80, we take 0·5 of the difference 0·203 taken from the table, and add this to the coefficient of rotative effort for the position of 0·90. We thus get 0·6475 as the approximate coefficient of rotative effort for the position 0·85, which is not given in the table.

The coefficients of rotative effort are multipliers, by which we must multiply the unbalanced pressure per square inch on the piston, less the part of that pressure that is converted into work of friction, in order to get the rotative effort on the crankpin exerted by the pressure on each square inch of the piston.

Example. — When the crank radius divided by the rod radius = ¼, the unbalanced pressure per square inch 80lb., and friction under load of the engine (friction being considered constant throughout the stroke) is 6 per cent. of the full working power of the piston at any point, what will be the rotative effort of each square inch of piston; and what will be the total rotative effort of a piston 10in. diameter, at piston-position 0·35?

This position is intermediate between 0·30 and 0·40. The coefficient of rotative effort for position 0·40 is 1·024, and for position 0·30 it is 0·974; the difference is 0·050, 0·5 of which is 0·025. This subtracted from 1·024 gives 0·999, the coefficient for position 0·35.

Again, 6 per cent. of 80lb. is 4·8, leaving the pressure 75·2lb., which will be converted into rotative effort on the crankpin; and $75\cdot2 \times 0\cdot990 = 75\cdot125$, which is the rotative effort per square inch of piston.

Again, a piston 10in. in diameter has an area of 78·54 sq. in. and $78\cdot54 \times 75\cdot125 = 5900$lb., which is the total rotative effort on the crankpin exerted by the total pressure on the piston.

Whenever the piston travels faster than the crankpin the rotative effort on the pin is less than the effort of the piston, and the converse is also true. From the table, therefore, it is possible to determine at any point whether the rate of motion of the crankpin in its circular path is greater or less than the rate of motion of the piston in its rectilinear path.

Thus at point 0·20 in all the columns of rotative effort, except for those in which $\frac{\text{crank radius}}{\text{rod radius}} = \frac{1}{2}$ or less, the piston is moving slower than the crankpin, while for the shorter rods it is moving faster. When both are moving at equal rate the coefficient of rotative effort will be 1·000.

The mean rotative effort on the crankpin in pounds multiplied by the distance in feet it travels during a semi-revolution is equal to the mean effective pressure in pounds upon the piston (after subtracting that absorbed by work of friction), multiplied by the length of the stroke in feet. This must surely be the case, otherwise there would be either creation of something from nothing or a subtraction of something from something without diminishing the thing subtracted from.

(*To be continued.*)

Trade Notes.

Several large orders for locomotives have just been placed with Glasgow firms. They are for Japan and the Cape.

The Denain and Anzin Steel Works, France, have secured an order for 500 tons of steel fishplates for the State railways.

The Bute Dry Dock and Shipbuilding Company Limited have declared a dividend of 10 per cent. for the year ended March 31.

Messrs. C. and W. Walker, Donnington, Shropshire, have obtained an order for the supply of six cast-iron purifiers for the Walsall Gasworks.

The Cockerill Company of Liege, Bel-gium, have contracted to supply 12,000 tons of rails, etc., for the Salonica-Dédeagatch Railway, Turkey.

Messrs. John Fowler and Co., Leeds, have received an order from the Great Northern Railway Company for ten engines required for their electrical station.

The directors of the Newport Dry Dock Wood and Iron Shipbuilding Company Limited, have declared a dividend at the rate of 4½ per cent. per annum for the past half-year.

The Hebburn Boiler Company, Hebburn-on-Tyne, have just turned out a large Lancashire boiler for Messrs. C. A. Parsons and Co., of Newcastle. It is 28ft. long and 7ft. 6in. diameter.

Messrs. G. Ansaldo and Co., of Sampier-darena, Italy, have received orders from the Italian Minister of Marine to construct two sets of marine engines to develop 13,000H.P. with forced draught.

Messrs. Alex. Wood and Sons, Glasgow, have received a large order for platform weighing machines of the highest quality for the Government dockyards at Portsmouth, Deptford, and Chatham.

Messrs. Nettlefolds Limited have issued a circular announcing a reduction in prices of no less than 25 per cent. The reduction has been brought about by an increase in gross discounts of 10 per cent., which now becomes 67½ per cent.

The Babcock and Wilcox Company, of Glasgow, London and Manchester, have received an order from the Edison Illuminating Company, Philadelphia, for the supply of boilers to be built entirely of wrought steel and to work at a pressure of 225lb. per square inch. They are to furnish steam for engines of 1700H.P.

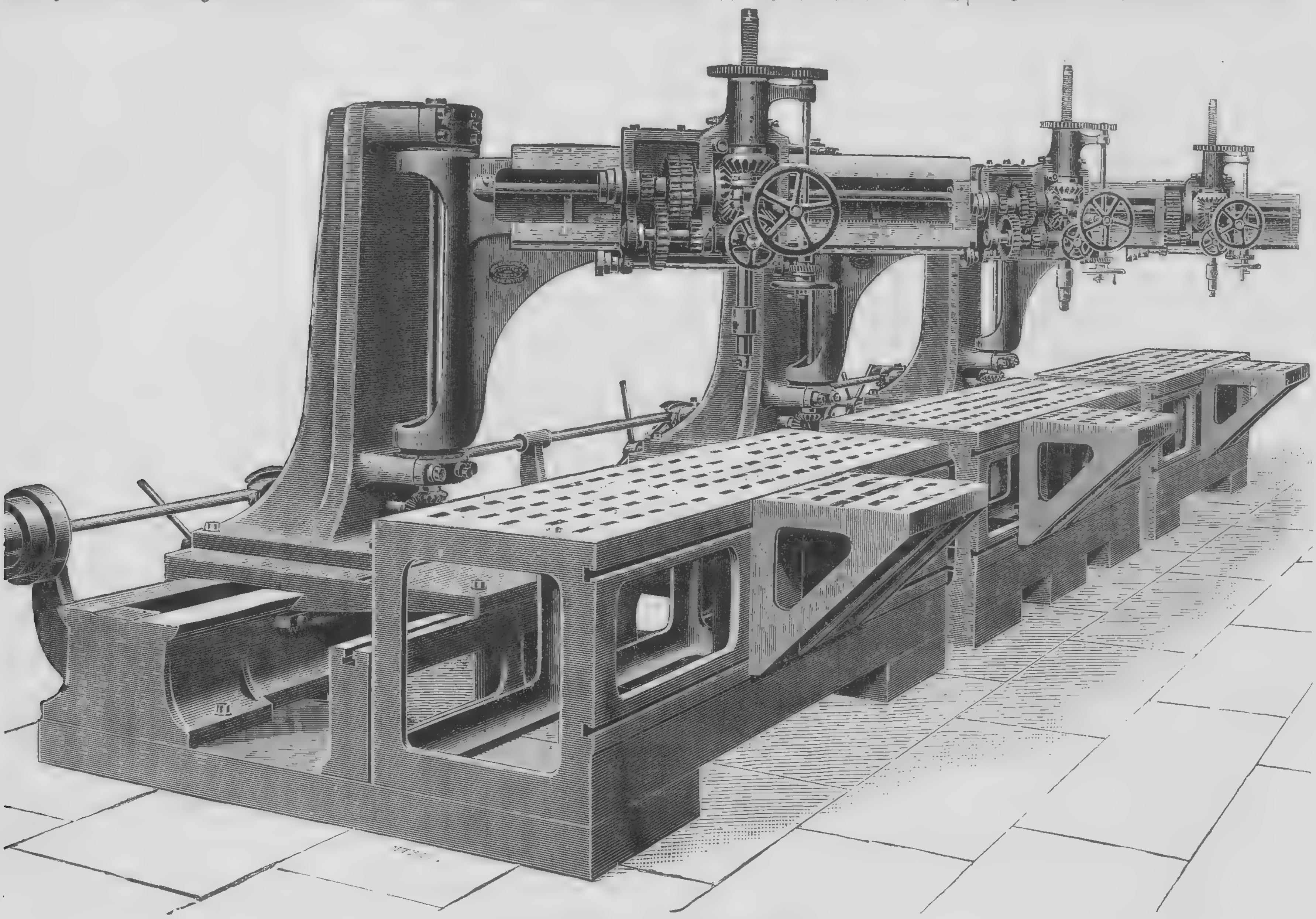
We notice with interest the rapid growth of the steel-tube trade, and especially the way in which the British Seamless Steel Tube Company, of Smethwick, Birmingham, have come to the front. This, although only a comparatively young company, is certainly making rapid advances. This company claim that their special "British" brand combines strength and lightness, qualities which are highly appreciated by engineers. A portion of their large works has been set apart for the manufacture of tubes for cycle makers, among whom they have a very large connection. We hear they have been several times compelled to increase their plant, a fact which bears testimony to the great favour which their tubes have already obtained.

Having regard to the enormous circulation of The Mechanical World, the Editor suggests that it is by far the best medium for the insertion of every kind of "Wanted" advertisement, and the price is only one halfpenny per word. The Editor will be glad if Mechanical World readers will kindly bear this in mind as occasion arises.

Readers of "The Mechanical World" are invited to send to the publisher of "Good Health," the new weekly paper devoted to food, drink, medicine and sanitation, for a parcel of specimen copies, which will be sent gratis and post free, for distribution among their friends at home and abroad. Address, 85, Strand, London, or New Bridge-street, Manchester.

Multiple-arm Radial Drilling Machine.

HEREWITH we give an illustration of a large multiple-arm radial drilling machine which has been specially designed by Messrs. John Hetherington and Sons Limited, Ancoats Works, Manchester, for drilling locomotive frame plates, girders, and ship-builders' work, where a large number of holes are required in heavy pieces. The machine consists of seven massive foundation plates, on which are mounted and securely bolted three rectangular box tables



MULTIPLE-ARM RADIAL DRILLING MACHINE.

—3ft. by 3ft. 1in. by 11ft. long,—planed on the top, bottom, and front faces. Slots are cast in the top; the front faces have the head slots planed from the solid, and each table is fitted with an angle bracket, or table, 2ft. 2in. by 3ft., securely bolted to the front face. One bed—36ft. long—of the lathe bed pattern is securely bolted to the seven foundation plates, and carries three massive carriages, which are accurately fitted to the bed, and provided with loose strips for taking up all wear, quick hand traverse for adjustment by rack, pinion gear wheels, and large crosses; there is a projection in front sliding, and bolted on an extra front support, running the full length, for taking up thrust and weight of overhanging arms. Three 7ft. double-geared radial arm drilling machines are mounted on these carriages, with arms 8ft. long from centre of pivot to end. The arms radiate in a complete half-circle, and will admit 5ft. from the face of the table to the underside of the spindle, which is of steel, 3in. in diameter, having a variable self-acting feed of 15in., by a steel screw and a special arrangement of nuts, so that all drop can be taken out. The machine is also provided, if desired, with carriages or heads, with rack feed to the spindles, which are balanced, and with quick disengaging and adjusting motions. The double gearing is placed in the head, thus giving off the power as near the work as possible, and preventing the extreme torsion of shafting and wear of the keys. The machine is constructed to drill holes from the solid up to 3in. in diameter, and bore holes up to 12in. in diameter, 15in. deep, in all circles from 2ft. 10in. to 7ft. radius, and it will command all holes on a surface 5ft. 2in. by 36ft. long. Each spindle is fitted with a reversing clutch, for tapping purposes, which may be omitted according to requirements. The whole machine is strong, powerful, and complete, with separate driving to each head, and three complete sets of top driving apparatus.

Mudd's Patent Tail-shaft Preserver.

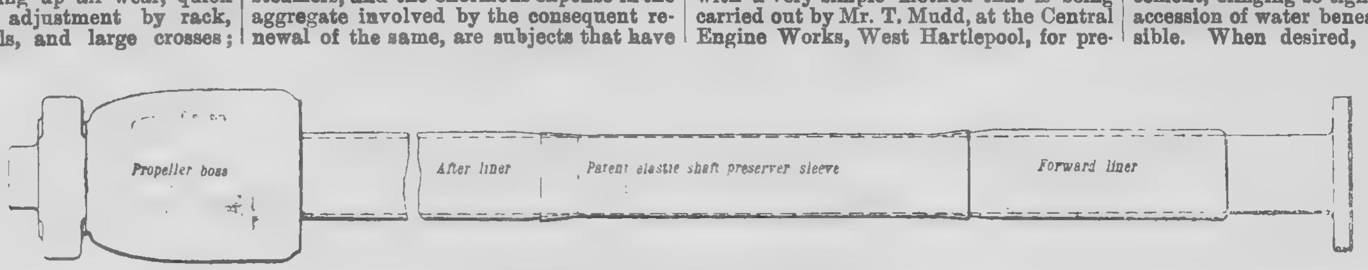
THE rapid decay of tail shafts in steamers, and the enormous expense in the aggregate involved by the consequent renewal of the same, are subjects that have exercised the minds of a great many ship-owners and engineers, and are matters of no small concern to underwriters.

It is generally conceded that a simple and reliable remedy, involving no radical change in existing practice and design, would prove a great boon to the ship-owner and the underwriter, and would result not only in the saving of a vast amount of capital, but of much privation and danger to those who go down to the sea in ships.

The question has been attacked from many points of view, but up to the present nothing appears to have been done that can be generally accepted as a satisfactory solution of the difficulty. This is probably owing to most of the remedies proposed having a relation to only one phase of the trouble, and so not covering the whole ground.

A tail shaft is, perhaps, the most severely tried of all the parts of marine machinery. Its hardships are of a multifarious character. Those which consist of shocks due to the beating of the propeller on the water, and to the passage of its blades past the stern post, are not now under discussion, but only those which attack the material of the shaft. The first of these is doubtless the galvanic action which arises immediately at the ends of the brass liners when immersed in water. The second is the general corrosive action that proceeds all along the middle part of the shaft between the liners, when exposed to salt water in the stern tube, and which is aggravated by the churning action produced therein, resulting in the water being largely mixed with atmospheric air.

We have the pleasure to illustrate herewith a very simple method that is being carried out by Mr. T. Mudd, at the Central Engine Works, West Hartlepool, for preventing both these causes from taking any effect upon the shaft. Mr. Mudd holds that the one great essential to be aimed at is keeping the water away from the shaft, and that if this can be done effectually the whole ground is at once cleared, because neither the corrosion nor the galvanic action can proceed at all without the presence of water. He is quite aware this idea is not new, as it has been attempted in several ways, such as by lengthening out the liners till they meet, and there brazing them together; but he believes it has never been effectually accomplished, and the covering of a shaft with brass all over is a very expensive expedient.



MUDD'S PATENT TAIL-SHAFT PRESERVER.

Mudd's patent tail-shaft preserver then consists simply of a tube or sleeve, made of first-class indiarubber or other elastic material, which tube is made of such dimensions as to cling tightly to the shaft over the whole length between the liners and for several inches up the inclined liners at its ends. For this purpose the liners are lengthened out about 6in. more than is usual, and gradually tapered away to accommodate the elastic sleeve. This gentle tapering of the liners has another good effect, as it gradually diminishes the strength of the liner, and so overcomes the objection to a sudden change of strength where the liner finishes, and which doubtless, in many cases, aggravates the damage caused by galvanic action at that point. When the preserver is to be put on the shaft, the latter is thoroughly cleaned bright and coated with a suitable cement, and, by means of special apparatus of a simple character, the sleeve is drawn over the end of the shaft until it is in its place, where it becomes embedded firmly in the cement, clinging so tightly as to make the accession of water beneath it quite impossible. When desired, the ends may be lashed with copper wire over wire gauze, and the lashings soldered together; but this appears to be an unnecessary precaution. If any should object that the sleeve is likely to become damaged by the shaft being pushed into its place in the tube, the answer is that this, too, has been carefully thought out, and a false nut provided which runs on the thread on the end of the shaft, the external diameter of which is precisely the same as the diameter of the brass liners, and which therefore holds up the point of the shaft as it passes through, preventing the elastic tube from being injured by the neck bush. This nut, of course, goes with the ship as

part of the outfit. As this scheme in no way interferes with existing design beyond requiring the lengthening of the liners, it is capable of application to all existing steamers when they are renewing or having new ends put on their tail shafts; and as it is a very inexpensive method of dealing with the question, as well as one that is likely to be a thoroughly practical and complete solution of the difficulty, it seems probable that it will soon be universally adopted, and regarded as just as ordinary a fitting as the lignum vitæ bush itself. The first vessel to be fitted was the s.s. "Aldworth," a large steamer having triple engines, built at the Central Engine Works.

On Testing Machinery and Electric Water-level Recording Apparatus.*

It has occurred to the author that a description of testing machinery and indicating apparatus in Glenfield Works might be interesting to the members of the Institution. Possibly most of the apparatus may be familiar—some may not be so. Testing is of such great importance at the present day that in any case a description may lead to a profitable discussion.

Machine for Testing Cast-iron Bars Transversely.—This is a lever machine (Fig. 1), having automatic arrangement for travelling the rolling weight. The lever is balanced, and is suspended by a screw, worked by bevel wheel and pinion, with hand wheel. The automatic arrangement consists of ratchet wheel and trigger, the rolling weight being pulled along the lever by falling weight in column, regulated by oil cataract.

The cast-iron test bars are broken upwards, and are usually 2in. × 1in. × 36in. centres. The deflection is given on a graduated friction ring, which is set to zero by hand after the test bar has been placed in the machine. The deflection is indicated to the third decimal point.

There are two lines of figures stamped on the steel lever.

- With the rolling weight only—read top line.
- One end weight reads 1000lb. less than bottom line.
- Two end weights—read bottom line.
- Each additional end weight adds 1000lb. to bottom line.

Provision is made for testing bars at 4ft. centres, and the bars may be 1in. square or of larger section than 2in. × 1in. if so desired. Links are fitted to the machine to test cast-iron tensile bars up to ⅝in. diameter, and wrought-iron or brass bars up to ½in. diameter. The machine is, however, made specially for testing cast-iron transverse bars, and although tensile bars *can* be tested, the machine is not so well suited for tensile tests as machines specially constructed for the purpose.

The bar is placed in position, deflection pointer set, and the wheel turned by hand. The rolling weight travels out automatically, and stops when the bar breaks. When a new machine is made the lever is tested by hanging dead weights on the centre. If the lever gets out of balance after that, the centres require looking to.

Mercurial Column for Testing Pressure Gauges.—The column (Fig. 2) is placed against a chimney stack. A pretty equal temperature is thus secured, and immunity from damage by frost. During the thirteen years that the column has been in use only once did a glass tube break.

The reservoir tube and column tubes are all of glass. The former is about ¾in. internal diameter, 1⅜in. external diameter; length 30½in. The latter are in lengths of about 20ft., about ⅛in. internal diameter, and ⅜in. external diameter.

The small tube, or column tube, passes down through a brass stuffing box at top, to the bottom of the reservoir tube. The column tube is continued to top of chimney, being protected in a wooden case lined with felt, with hinged doors. An iron ladder is carried up alongside to top of chimney, which is 60ft. high. The lengths of column tube are connected by gun-metal couplings. It is not necessary that either the reservoir or column tubes be absolutely uniform in bore. They cannot be so got as a matter of fact. There is a long sliding rule carried in a groove in wood casing alongside the column tube, graduated in feet and inches. The reservoir tube has been graduated by reading from level to level of the mercury, so that the accuracy of graduations on the reservoir tube can be checked at any time. Water is pumped on the surface of the mercury in the reservoir tube by a small hand pump. The gauges to be tested are fixed on the small standards beside the reservoir tube, and their graduations checked off from column.

The column gives readings up to 360lb. per square inch.

The equivalent in column of mercury for

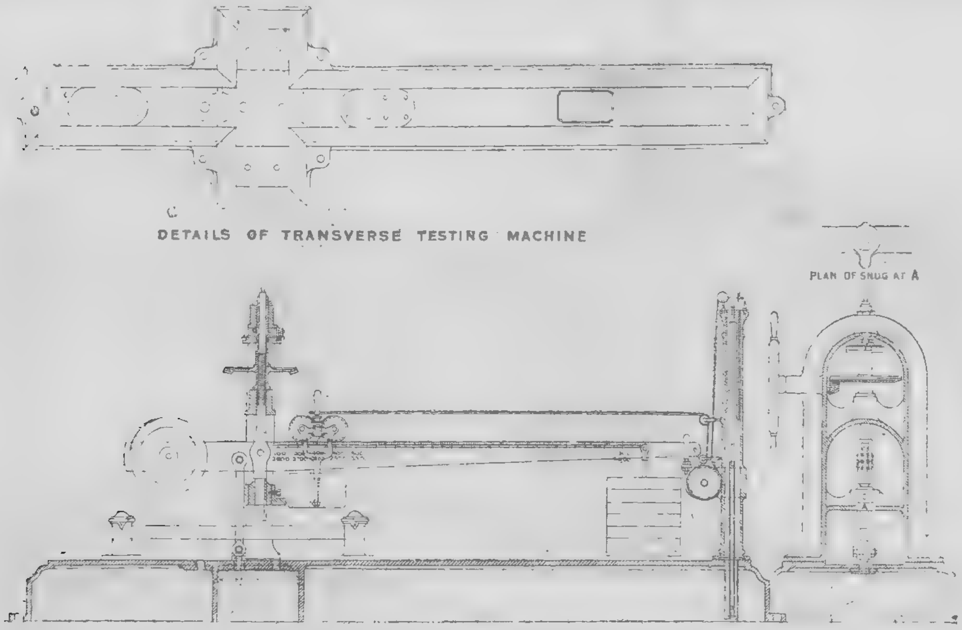


Fig. 1.

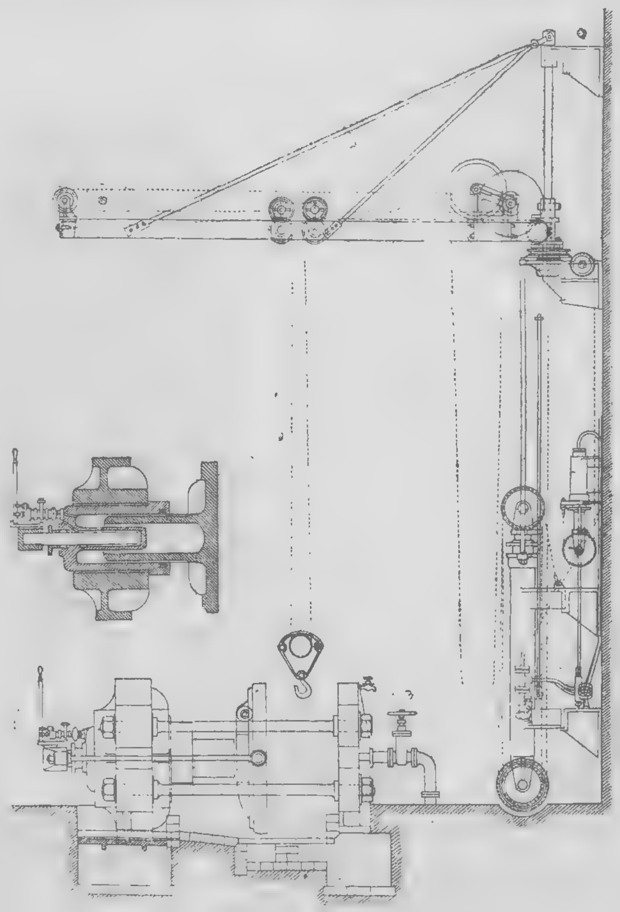


Fig. 4.

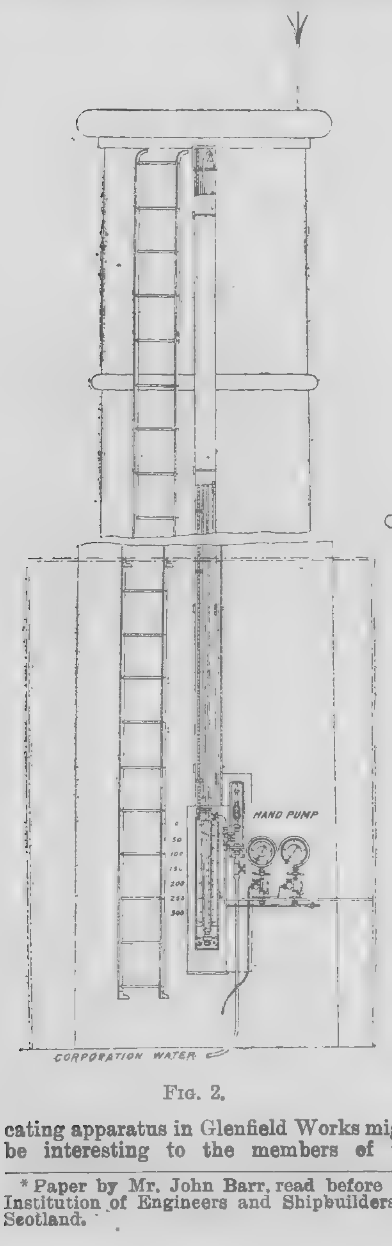


Fig. 2.

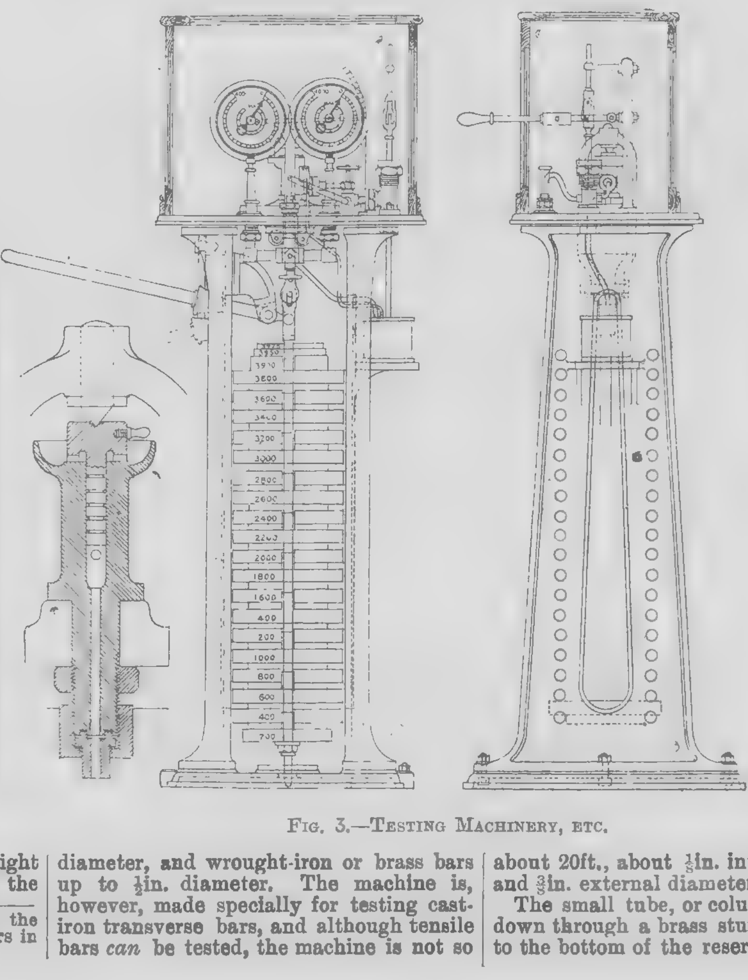


Fig. 3.—Testing Machinery, etc.

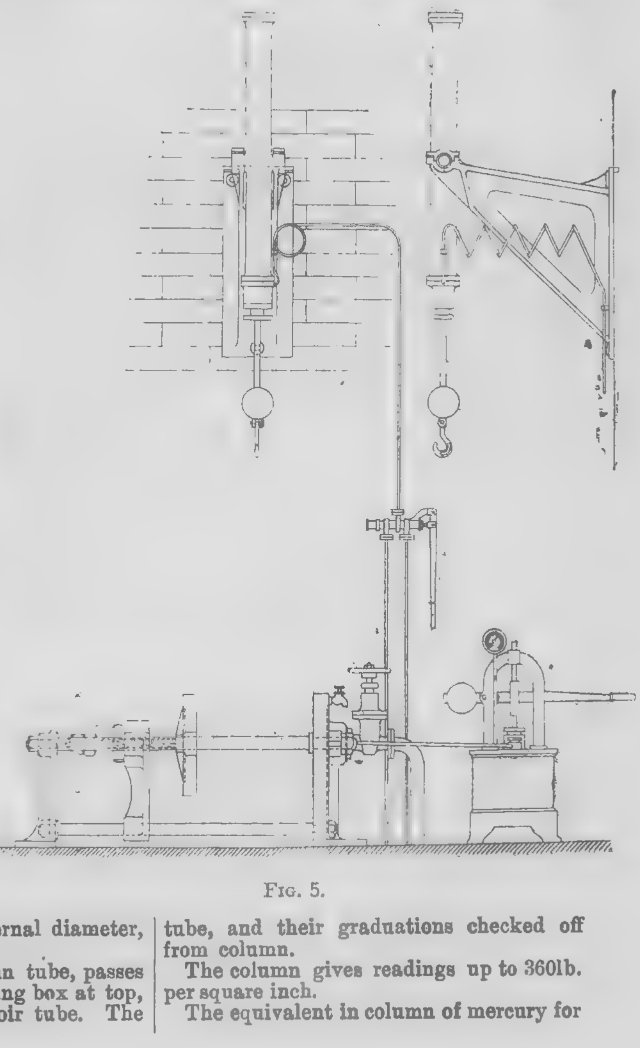


Fig. 5.

* Paper by Mr. John Barr, read before the Institution of Engineers and Shipbuilders in Scotland.

1lb. per square inch is arrived at in the following manner:—

Specific gravity of mercury at 32° F. compared with water at 39·1° F.: Volkmann = 13·593, Regnault = 13·5959, British Association Electrical Standards Committee = 13·5956. This last has been adopted.

Normal temperature 62° F. $= \frac{(62 - 32)\,5}{9}$ = 16·666° Centigrade.

Coefficients of expansion of mercury per 1° C. = 0·00018153.

The specific gravity of mercury at 62° F. compared with water at 39·1° F. will therefore be $\frac{13 \cdot 5956}{1 \cdot 0030242898}$ 13·5545.

Specific gravity of water at 62° F. compared with water at 39·1° F. = 0·99889.

The specific gravity of mercury at 62° F. compared with water at 62° F. will therefore be $\frac{13 \cdot 5545}{0 \cdot 99889} = 13 \cdot 5695$.

One inch of mercury at 62° F. is therefore equal to 13·5695in. of water at same temperature.

One foot of water is therefore equal to $\left(\frac{12}{13 \cdot 5695}\right)$ 0·884332in. of mercury.

One cubic foot of pure distilled water at 62° F. weighs 62·2786lb.

The equivalents in feet head of water for 1lb. per square inch will therefore be:—

$$\frac{\text{cub. in. in cub. ft.} = 1728}{62 \cdot 2786 \times 12} = 2 \cdot 3121.$$

The equivalents in inches of mercury for 1lb. per square inch will therefore be: 0·884332 × 2·3121 2·044636272.

Note.—Authorities do not agree as to the weight of a cubic foot of pure distilled water at 62° F. There are said to be 277·123cub. in. in a gallon. Act of Parliament of 1825 gave it as 277·274, but this Act is now partly repealed, and the correct capacity is given as 277·123. The number of gallons in 1 cub. ft. will therefore be:—

$\frac{1728}{277 \cdot 123} = 6 \cdot 2354$. As 10lb. is said to be the correct weight of a gallon of pure distilled water at 62° F., the weight of a cubic foot of water should be 62·354lb.

	Lb.
D. K. Clark gives it as	62·355
Box (Hydraulics) as	62·321
Molesworth as	62·425
Latimer Clark (latest estimation, 1890)	62,2786

The last-mentioned has been adopted by the author. If it is correct, then the true weight of a gallon of water at 62° F. will be $\frac{62 \cdot 2786}{6 \cdot 2354} = 9 \cdot 9879$lb. avoirdupois.

Machine for Testing Pressure Gauges up to 4000 or 5000lb. per Square Inch.—This machine (Fig. 3) consists of a loaded plunger of forged bronze, working in a gun-metal cylinder. The plunger is 2⅝in. long, and has a few grooves on its surface to form receptacles for any dirt or grit that may get on to it. The plunger, which is ½in. in diameter, is such a nice-working fit in the cylinder that the leakage is practically of no account—it amounts to 13 drops of oil per minute, at a pressure of 4000lb. per sq. in. Fine sperm oil is used in testing. It is pumped into the cylinder by a small hand-lever pump. The leakage past plunger is carried by a small tube back into oil vessel. Stop-valves are provided so that the pressure can be shut off from the cylinder, or from the gauges.

The load, which is a direct dead load, bears on top of plunger on a centrepoint of steel—the weights having slots to pass them on the spindle between the standards of the machine. By means of the hand lever shown, weights can be taken off or put on spindle without removing them. Each weight (stamped by Government) represents 200lb. per sq. in.; smaller weights represent 100lb., 50lb., 20lb., 10lb., etc.

The plunger has capstan handles, which enable it to be turned by hand, thus eliminating any friction that may be caused by adhesion, grit, etc. It is so sensitive that when loaded to 4000lb. per square inch a slight vibration (by stamp of the foot) of the machine, or floor on which it rests, causes the index pointer of machine and needles of gauges to vibrate very visibly.

The diameter of the plunger (half-an-inch) is to Whitworth standard, and was checked by mercurial column. A gauge tested on the column indicates exactly the same on the high-pressure machine.

The small balanced index pointer shows at a glance when the plunger is floating.

The whole of the upper part of the machine is protected from dust by a case of mahogany and glass, which is lifted off when a gauge is being tested.

High pressure gauges made on the Continent either seem to be graduated to a different standard, or they are graduated erroneously, possibly both. The following are tests of high-pressure gauges made quite recently:—

Machine indicated lb. per sq. in.	Continental Gauges newly purchased.			Gauges about 1 year old.		Gauges about 4 years old.	
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.
200	—	202	206	—	—	—	—
400	—	403	408	—	—	420	450
418	443	—	—	—	—	—	—
600	—	618	622	—	—	—	—
672	672	—	—	—	—	—	—
800	—	825	832	—	—	—	—
900	916	—	—	—	—	—	—
970	—	1000	1003	—	—	—	—
1000	—	—	—	1010	1080	1050	1080
1120	1150	—	—	—	—	—	—
1400	1440	—	—	—	—	1460	1490
1500	—	—	—	1547	1602	—	—
1800	1840	—	—	—	—	1875	1900
2000	—	—	—	2070	2104	2080	2100
2245	2310	—	—	—	—	—	—
2400	2464	—	—	—	—	2520	—
2500	—	—	—	2575	2600	—	—
2600	2670	—	—	—	—	—	—
2800	—	—	—	—	—	2930	—
3000	—	—	—	3090	3136	3150	—
3050	3136	—	—	—	—	—	—
3400	—	—	—	—	3528	—	—
3500	3584	—	—	—	—	—	—
3925	4032	—	—	—	—	—	—
4000	4106	—	—	—	4142	—	—

It will be observed that the older the gauge becomes the spring gets weaker—which is to be expected—corrosion probably being the chief cause. Then, again, the error is on the safe side—the gauges showing more than is actually on the article under test. Inspectors, on the other hand, are not likely to accept a test 5 or 10 per cent. under the actual value, if they know of it.

Machines for Testing Sluice Valves and Pipes.—These are shown in Figs. 4 and 5. There are five machines in all—viz.:—

One hydraulic machine to test up to 48in. dia.
Two screw " " 24 "
Two " " " 12 "

Hydraulic Machine.—A three-ton hydraulic crane is swung right over this machine for lifting valves, etc., to be tested in and out of machine. Heavier pieces are lifted by 20-ton overhead traveller.

The machine is very similar to what is used in pipe foundries for testing pipes, and consists of front and back heads, and shifting plate. The front head contains hydraulic cylinder and ram, 14¾in. diameter by 21in. stroke. The back head has supply pipe, 3in. diameter, in centre. Water is supplied from overhead cistern, 30ft. above. When filled, the test pressure is put on the valve or pipe being tested by a set of three throw plunger pumps. The hydraulic head is connected to accumulator pressure of 700lb. per square inch. When greater power is required to make the joints between shifting plate and back head of machine, a few strokes of a hand pump does the necessary. The four tie rods are each 4in. diameter. The whole machine weighs about 17 tons. The back head is furnished with air passage and screws to take out to suit varying diameters, with air cock at top. In some machines that have been made the test pressure is also put on from accumulator, by means of a pressure-reducing valve. A similar appliance is also furnished at the hydraulic head, to prevent too much end pressure being put on when testing pipes of small diameter, or wrought-iron pipes, which latter would be buckled.

The three throw pumps used in the case of the machine just described are belt-driven, and have plungers 1½in. diameter by 4½in. stroke, and run at 75 revolutions per minute. They are constantly at work. The pressure is equalised by an air vessel, and can be varied at will by means of a spring-loaded relief valve, the surplus water pumped being discharged into overhead cistern. These pumps also supply pressure water for the tap testing apparatus described further on.

Screw Machines.—The screw machines are so arranged that the length of space available for testing a valve or pipe can be quickly lengthened or shortened, by means of cotters dropped at equal distances into the side bars of the machine. These machines are furnished with hand-pumps, the water for filling being from the overhead cistern before referred to.

The two smallest screw machines (12in.) are each furnished with a direct-acting hydraulic lift, placed directly over the machine, the cylinder being hung by trunnions on a wall bracket, to permit of swinging the valve to be tested into or out of the machine. The lifts each raise half-a-ton.

(*To be continued.*)

London Association of Foremen Engineers and Draughtsmen.

THE anniversary festival of this association was held in Cannon-street Hotel on Saturday evening, April 22, when about 160 gentlemen sat down to dinner in the great hall, and about 40 ladies graced the assemblage with their presence.

The chair was occupied by Major General Charles E. Webber, C.B., etc., and the vice-chair by Frederick C. Frye, Esq., M.P., and among the guests were a number of the principal engineering employers in the London district. After dinner the usual loyal and other toasts were proposed and responded to. During the evening subscriptions were announced from gentlemen present and other friends, in aid of the benevolent funds of the association, amounting to over £130.

Metal Trade Memoranda.

It is stated that new aluminium works are to be erected at Lengefeld, in Voigtland, Germany.

Messrs. S. Hildschinsky and Sons, of Kattowitz, are building ironworks in Austrian Silesia, for the manufacture of rolled iron.

The production of pig iron in Germany during the first quarter of the year is officially reported at 1,134,882 tons, as against 1,200,719 tons in the corresponding period of 1892.

The Dortmund Union, Germany, is about to raise a loan of 18,000,000 marks, the proceeds of which are to be applied to the construction of a tube-rolling mill and other improvements.

The Detroit Dry Dock Company, Detroit, Michigan, is contemplating the use of nickel steel in the manufacture of boilers for marine purposes, the idea being that higher pressures would be obtained from boilers of much less weight than are at present carried.

The Victoria Ironworks, Walsall, belonging to Messrs. Walker Bros., galvanised-sheet makers, have been closed in consequence of the low price of iron and the high price of coal. The stoppage is only temporary, and affects the black-sheet ironworks but not the galvanising department.

Amongst the numerous new steel processes lately reported, is the Dawson process, which is said to have been tried recently in Cincinnati. In this process the inventor takes scrap iron or steel and treats it with chemicals while in a state of fusion in an ordinary crucible. It is said that when melted the liquid metal is cast in sand in any desired shape, the result being a casting of the highest grade of steel. The rolling manipulations are dispensed with. It is found that the product has combined carbon, but in quantities so small that under the old process it would be utterly valueless.

New Companies.

ELECTRIC LIGHT REGULATING SYNDICATE LIMITED.—This company was registered on the 25th ult., with a capital of £1000, in £1 shares, to enter into an agreement between E. P. Davis and A. C. Collins, and to carry on the business of electricians, mechanical engineers, and suppliers of electricity for the purposes of light, heat, and motive power. The rules of Table A apply. Registered office, 8, Broad-street Avenue, E.C.

MERVEILLEUSE ELECTRIC ARC LAMP SYNDICATE LIMITED.—This company was registered on the 24th ult., with a capital of £15,000, in £1 shares, to adopt and carry into effect, with or without modification, an agreement dated the 20th ult., and made between Emilio Zuccani and A. Conder, for the purchase of the patent rights of the "Merveilleuse" electric arc lamp for the United Kingdom of Great Britain and Ireland, and to carry on the general business of electricians. The rules of Table A usually apply. Registered office, Crown Court, Old Broad-street, E.C.

JOHN OAKEY AND SONS LIMITED.—This company was registered on the 21st ult., with a capital of £ 25,000, in shares of £10 each, to acquire and take over as a going concern the business of emery, glass, paper, blacklead, emery cloth, and knife polish manufacturers, heretofore carried on at the Wellington Mills, Westminster Bridge road, Lambeth, under the style of "John Oakey and Sons," and to carry on this undertaking in all its branches. The first directors are: H. Oakey, G. L. Bazard, Benjamin Gallaway, G. Blackman, Daniel Stock, and T. Maskall; qualification, £2000; remuneration, £500—divisible. Registered by William Wade Palmer, 171, Queen Victoria-street, E.C.

METALLO-CHROME PRINTING COMPANY LIMITED.—This company was registered on the 26th ult., with a capital of £50,000, in 15,000 preference and 35,000 ordinary shares of £1 each, to adopt an agreement made on the 6th ult. between the Home, Foreign and Colonial Company Limited and H. Morris, and to carry on in Great Britain and elsewhere the businesses of mechanical engineers, machinists, founders, printers on metal, and the like. The majority of the rules of Table A apply; the qualification of a director is 100 shares, and his remuneration is to be £1 1s for each meeting attended, together with percentage on the profits. Registered by Devonshire, Monkland and Davies, 1, Frederick-place, E.C.

R. BOLTON AND COMPANY LIMITED.—This company was registered on the 22nd ult., with a capital of £12,000, in 1400 6 per cent. preference and 1000 ordinary shares, all of £5 each, to carry into effect an agreement made between Reginald Bolton and H. Coward, and to carry on such financial, commercial, manufacturing, trading, or other operations and businesses as may be thought fit. The number of directors is not to be less than two nor more than seven, the managing director being R. Bolton; qualification, £100. The members of the board are not to receive any remuneration, but are to be compensated for such services as they may render as employés or agents of the company. Registered by Russell and Co., 17, Great Winchester-street, E.C.

The Metal Market.

PRICES CURRENT.

LONDON, May 1.

COPPER opened easy and 2s. 6d. lower at £44 17s. 6d. three months, which position being freely offered soon declined to £44 16s. 3d., while cash in a week sold from £44 10s. to £44 8s. 9d. With less offering the tone then became steadier, and transactions in three months were done at £44 17s. 6d. and £44 16s. 3d. combined, cash making £44 8s. 9d. and 22 days £44 11s. 3d. On renewed selling, however, in the afternoon the improvement was lost, three months being freely sold at £44 16s. 3d. and cash at £44 7s. 6d., and final rates are 3s. 9d. lower on the day. Sales, 850 tons. Settlement price, £44 7s. 6d. English tough, £47 10s. to £47 15s.; best selected, £49 to £49 5s.; strong sheets, £56 15s.

TIN began 5s. lower, at £88 5s. three months, but with support three months rallied to £88 10s., and £93 5s. was paid for May sellers option one day's notice. The firmness of silver and better American advices kept the market firm, cash ruling at £93 2s. 6d., and on balance values are unaltered. Sales, 60 tons. Settlement price, £93 2s. 6d. English ingots, £96. The shipments of Straits during the past month are officially cabled as 2290 tons, of which 1390 tons are for London, 580 for America, and 320 for the Continent. According to Messrs. Strauss and Co., the deliveries last month were 1531 tons, against 1172 last April, and the quantity on spot and landing 3714 tons, against 3558 last month and 2502 last year, the visible supply now being 17,779 tons, against 18,530 tons a month ago and 11,566 tons in 1892. Amsterdam market firm; Billiton 55, and Banca 55¾.

PIG IRON has ruled quiet. There was a buyer at 40s. 7½d. during early trading, and a seller at 1d. more, but towards the close only 40s. 7d. was bid. The close was dull, with sellers at about Friday's rates. Settlement prices:—Scotch, 40s. 8d.; Middlesbrough, 34s.; hematite, 45s. 5d.

TINPLATES are dull and unchanged. I.C. cokes, f.o.b. Swansea, 11s. 7½d.; Liverpool, 12s. 1½d.; London, 12s 7½d.

LEAD has been quiet at late currencies, Spanish, £9 15s. sellers, £9 13s. 9d. buyers. English, £9 17s. 6d.

SPELTER is firm at £18 2s. 6d. for May shipment, with buyers at £18 1s. 3d.

ZINC SHEETS.—Silesian are fairly active at £21 ex ship. Belgian firm; V.M. brand, £21 5s. ex ship, and £21 2s. 6d. f.o.b. Antwerp.

OFFICIAL CLOSING QUOTATIONS.

	To-day.					
	£	s.	d.	£	s.	d.
COPPER—						
G. M. B.—Cash	44	7	6—	44	15	0
" Three months	44	16	3—	45	3	9
TIN—						
Fine foreign—Cash	93	2	6—	93	12	6
" " Three months	88	10	0—	89	0	0
Australian—Cash	93	15	0—	94	5	0

PIG IRON—

	Scotch.		Middlesbrough.		Hematite.	
	Cash. s. d.	1 m'th. s. d.	Cash. s. d.	1 m'th. s. d.	Cash. s. d.	1 m'th. s. d.
Close	40 8	40 10½	34 0	34 2	45 5	45 7
Prev. close	40 8	40 10½	34 0	34 2	45 5	45 7½

Official Gazette.

Partnerships Dissolved.

V. S. ALLPRESS and T. O. BELSHAW, electrical and mechanical engineers and contractors, Victoria-street, S.W., under the style of Allpress and Belshaw.

G. HEATH and L. LEVI, St. Andrew's Dock, Kingston-upon-Hull, engineers, millwrights, brass founders, brass finishers, coppersmiths, and electric engineers, under the style of Heath, Levi, and Co.

J. CONNOR and J. MCINTYRE, under the style of J. Connor McIntyre, Liverpool, metal merchants.

F. PAYNE, A. R. BONNICK, and T. FROST, under the style of Payne, Frost and Co., Coventry, gas and oil engineers; so far as regards F. Payne.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Receiving Order.

THOMAS DAWSON, Halifax, machine and general smith.

Adjudications.

THOMAS DAWSON, Halifax, machine and general smith.

WILLIAM DAVIS HOPE, Chorlton-cum-Hardy, Lancashire, and Manchester, iron and steel merchant.

DAVID MORGAN DAVIES, trading as D. M. Davies and Co., Newport, colliery and mill furnishers and iron and steel merchants.

Order made for Discharge on Application.

JOHN LEAKE DEXTER, High Wycombe, engineer and ironfounder, trading in copartnership with John Langston, as Dexter and Langston—discharge suspended for two years from July 18, 1892, ending July 18, 1894.

Letters to the Editor.

**** We do not hold ourselves responsible for opinions expressed by correspondents.*

**** The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

**** Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

TESTING AND ANALYSIS OF IRON AND STEEL.

To the Editor of THE MECHANICAL WORLD.

SIR,—In your issue of April 21, under the heading of "Testing and Analysis of Iron and Steel," by Messrs. Leadbeater and Hodgson, it is stated at the end of that article that the manganese precipitate obtained as directed consists of MnO_2 *upon ignition*. It is generally understood that this ignited precipitate is not MnO_2, but Mn_3O_4 (which contains 72·05 per cent. Mn). Perhaps Messrs. Leadbeater and Hodgson will explain. LOOKER-ON.

Wigan, April 25.

RAILWAY SPEED.

To the Editor of THE MECHANICAL WORLD.

SIR,—If Mr. Stretton will refer to the "Engineer" for March 7, 1890, he will find that the North-Eastern compound's high-speed was timed by a stop-watch, not by a speed indicator. This being so, his statements regarding the working of the speed indicator are not at all to the point. Then, again, I was under the impression that the trials of this engine (No. 1518) were under Mr. Worsdell's supervision. How, then, does Mr. Stretton account for his statement regarding the working of the speed indicator? Was he on the footplate along with that gentleman? Your correspondent has a perfect right to his own opinions on this subject; but I do think he should think twice before making assertions like these in the face of results obtained by the above eminent engineer. COMPOUND.

Bishop Auckland, April 28.

AUSTRALIAN LOCOMOTIVES.

To the Editor of THE MECHANICAL WORLD.

SIR,—In the Miscellaneous Items of your issue for February 3 you make it appear that the first locomotive built in Australia has just been completed at the works of Messrs. David Munro and Co., Melbourne, for the Victorian State Railways. Being an Englishman, and wishing to do justice to the Victorians and their colony, I beg to inform you that the first colonial-made locomotive was built at the Phœnix Foundry, Ballarat (Vic.), and delivered to the Victorian Government on February 6, 1873. A banquet was held on the completion of the hundredth locomotive in 1883, and the shop foreman, in his evidence before the Railway Inquiry Board last week, stated that he had seen 230 locomotives built during his time at the Phœnix Foundry.

I believe Messrs. Robison Bros., of Melbourne, built several locomotives for the Victorian railways in 1880.

Some of our largest engines were built in the colony, and are running on our main lines—viz., express—between Melbourne and Sydney, and Melbourne and Adelaide. I trust you will find room for this explanation, though it will be rather old by the time it reaches you.

Melbourne, March 28. F. G. L.

Miscellaneous Items.

The gold shipped from New York since the beginning of the year for this side of the Atlantic amounts to £9,800,000.

Telephonic communication between Reading and London has been completed, the line being opened on the 24th ult.

A number of green diamonds have been found in the gold quartz at Klerksdorp. This is an unusual occurrence, and has caused much speculation among South African miners.

The "Campania" arrived at New York on the 29th ult., from Liverpool, accomplishing the voyage in six days eight hours and thirty-four minutes, thus breaking the record for maiden voyages.

It is proposed to put down an electric power plant of 170H.P. in the Kanotuna mining district, New Zealand. All electrical machinery and appliances, including electromotors, hand dynamos, battery cells, etc., imported into New Zealand are admitted free of duty.

The oldest German railway line was opened in December, 1835, and ran between Nuremberg and Furth. Although the Liverpool and Manchester line was then in working order, the greatest difficulty was found in raising the capital for the new line, though only about £11,000 was required.

Arrangements have been made with the French Post Office for the delivery by express messenger of letters, etc., for France posted in this country marked "Express" and prepaid 3d. in addition to the ordinary postage, and also for the express delivery of correspondence coming from France.

Seventeen houses constructed entirely of hollow glass bricks will figure at the Chicago Exhibition, where they will be used as offices, workshops, and stores. A highly decorative effect will be obtained by using bricks of variegated glass, adhering to each other by means of colourless cement, a building of this nature lit from within by electricity presenting a fairy-like aspect unapproached by structures of sheet glass and iron.

Messrs. Maxwell and Tuke report satisfactory progress with the erection of the Blackpool Tower, which is now 203ft. 9in. high, with the exception of a few braces. The riveters are following up the work rapidly, and if all goes well the tower will be completed within the specified time. The electric crane, the first of its kind ever made, is lifting 85 tons a week. Up to the 22nd ult. the total amount of iron and steel erected was 1613 tons.

The smokeless powder which has been manufactured in Russia during the last eight months, it is stated, has been found to be utterly useless after five months' keeping, and is all being destroyed. The cause is some defect in the cotton which forms the basis of the powder, and all attempts have failed to discover a satisfactory way of preparing it. An inventor of a kind of celluloid made from straw is now offering his invention as a substitute for cotton, and first experiments are said to be satisfactory, although it may fail to stand the test of keeping.

Some time ago an action against Messrs. Barry, Henry and Co., was raised in the Court of Session by Messrs. Harpers Limited, Aberdeen, craving for interdict, it being alleged that the defenders had infringed the pursuers' copyright catalogue and circulars. Messrs. Harpers subsequently threatened to raise an action of damages in respect of the infringement, and the defenders have now settled the case by agreeing to pay £1000 to the pursuers. This, it may be added, practically settles for the first time in Scotland the law regarding the copyright of circulars.

Mr. L. Newitt, electrician at the Elswick Works, in reference to electrical search lights, said in a recent lecture that it might be interesting to hear what happened during the late war around the coast of Egypt. Some of the ships had instructions to follow the movements of the enemy by the aid of the search light, which in every case was more than two miles from the shore. However, in spite of this great distance, it was found that millions of winged insects were attracted by this beam of light, and travelled along the beam until they struck the glass in front of the projector and fell into the well around the search light, where they accumulated into a mass 2ft. deep.

A new nut lock, invented by Angus Fougere, consists of an ordinary bolt and nut, the lock being a secondary nut, about the size of a thick washer, in which a thread is cut in such a way that when lightly screwed in the plane of the washer it is inclined from 3 to 10degs. to the plane of the nut. The washer is made of mild steel, and screwed up tight against the nut, which forces its threads from their natural position, and thus causes the washer to bind on the bolt. It is said that the nut cannot be started, nor the thread of the bolt injured by vibration; nor can the nut be loosened by a wrench unless the lock is unscrewed. The Inter-Colonial Railway Company, of Canada, has had some 2500 of these locks in use for upwards of twelve months.

Prize Competition.

WE OFFER FOUR GUINEAS MONTHLY IN PRIZES FOR THE BEST ORIGINAL ARTICLES SENT IN ON ANY MECHANICAL, ENGINEERING OR ELECTRICAL SUBJECT.

IN ORDER THAT MANAGERS, DRAUGHTSMEN, FOREMEN, AND WORKMEN WHO HAVE HAD NO PRACTICE IN WRITING MAY NOT HESITATE TO SEND IN COMPETITIONS, IT IS TO BE UNDERSTOOD THAT ALL ARTICLES WILL BE FULLY EDITED AND CORRECTED, AND JUDGED OF SOLELY ON THEIR MERITS AS ORIGINAL CONTRIBUTIONS FROM A PRACTICAL POINT OF VIEW. THE OBJECT OF THE COMPETITION IS TO INDUCE PRACTICAL MEN TO COME FORWARD AND GIVE THE RESULTS OF THEIR EXPERIENCE.

CONDITIONS.

Competitions for our Monthly Prizes must be sent so as to arrive at the Manchester Offices of THE MECHANICAL WORLD, New Bridge-street, not later than the last Tuesday in each month. Articles arriving after that time will be placed in the following month's competition.

Written competitions must be on one side of the paper only. The contributions must be original, and relate to matters connected with Engineering, Mechanism or Electricity.

The Proprietors of THE MECHANICAL WORLD reserve the right to publish any competition, whether it gains a prize or not.

The competitions may be accompanied by diagrams, sketches or drawings.

Competitors should write the words "Prize Competition" on the envelopes.

Competitors are not confined to one, but may send any number of competitions.

The correct name and address of the sender *must* be distinctly written upon every competition, not necessarily for publication. Competitions can appear under a *nom de plume.*

☞ We cannot undertake to be responsible for any MSS. sent to us, though when stamps are enclosed for the purpose we will endeavour to return rejected contributions.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ **Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.**

BRIGHTENING CHAINS.—Can any correspondent inform me what material to use in a shaker to brighten chains?—W. B.

WOOD'S AUTOMATIC PRESSURE RELIEF VALVE.—Required the address of Mr. W. Wood, the maker of the above.—B. AND CO.

JIGS FOR DRILLING.—The Americans often use what is termed a jig for drilling. Will anyone kindly give a sketch, together with drill?—DRILLER.

COST OF M.S. AND L. RAILWAY.—Can anyone inform me what was the cost per mile of the M.S. and L. Railway from Manchester to Grimsby?—LOW DROP

WARSOP AERO STEAM ENGINE.—Any information about the working of the above engine, tried about 1870, such as the effect on the boiler, cylinder, piston rod, etc., will oblige—M.R.

CLEANING BOILER TUBES.—Will some reader describe a useful tool to remove hard, thick scale from cross tubes in a vertical boiler? Tubes 9in. diameter and 4ft. 6in. long.—NOVICE.

DYNAMO.—Can any reader inform me whether a dynamo, wound to give 10 ampères at 55 volts at a given speed, would be damaged if driven at twice the speed; and, if not, what output would it give?—J. O.

TRACTION ENGINE.—Occasionally it is necessary to fit a new face on to the old face in steam chests on which slide valve works, in traction and other engines. What kind of metal is used in such a case?—FACE.

POWER RENTAL.—I am desirous of supplying steam power to a tenant from an engine driving his own works. How is the value of such to be ascertained, and what is the fair price for 100I.H.P. per week of 54 hours; also for 8I.H.P. similarly supplied?—POWER.

KEYS, COTTERS, ETC.—Can anyone inform me what kind of steel is used for making keys and cotter pins as used on most engines? The keys that are bought seem to be of better quality than the so called mild steel as sold at very little more than the price of fair merchant iron.—STEEL.

STEAM REVERSING GEAR.—I should be much obliged if any reader will explain the working of a steam reversing gear for locomotives, which I have seen on the following railway companies' engines:—Glasgow and South-Western, Mersey Tunnel, and South-Eastern. A sketch would assist me.—F. TURTON.

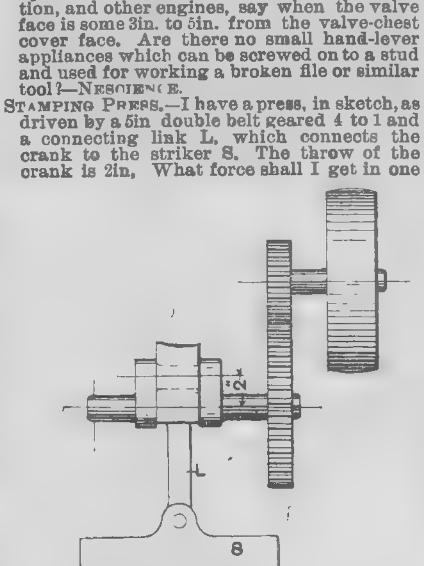
THEORETICAL DIAGRAMS.—Will any reader sketch and describe the theoretical indicator diagrams which would be obtained from a set of triple-expansion engines, having given—Load on safety valves, 150lb.; height of barometer, 30in.; ratio of cylinder volumes, 1, 2¼, 5; total ratio of expansion, 8.—HYPER.

TUBBING.—What system ought to be adopted in the renewal of tubbing in a shaft which has become faulty in the middle of a length of tubbing 25 fathoms from the surface—pit 15ft. and 100 fathoms deep? Kindly explain what method to use to secure the greatest safety and make the most permanent work.—J. M.

METALLURGICAL FURNACE.—Can any reader furnish me with a scheme for supplying the heating power necessary for a metallurgical laboratory situated in iron-ore mining district, and where no gas is available? A small muffle furnace would be required, in addition to the ordinary heating power, and the fuel used is charcoal. Accommodation only required for one chemist.—H. S.

FACING SLIDE VALVE FACES.—I require a hand appliance, not expensive, suitable for getting up the faces of slide valves of portable, traction, and other engines, say when the valve face is some 3in. to 5in. from the valve-chest cover face. Are there no small hand-lever appliances which can be screwed on to a stud and used for working a broken file or similar tool?—NESCIENCE.

STAMPING PRESS.—I have a press, in sketch, as driven by a 5in double belt geared 4 to 1 and a connecting link L, which connects the crank to the striker S. The throw of the crank is 2in. What force shall I get in one



blow on the table A, and how shall I calculate the force if a fly-wheel is added, say 3ft. diameter and weighing 300lb? The thickness of the material to be stamped is 1/16in., the depth about 3in., and the area of stamp 400sq. in.—YOUNG DRAUGHTSMAN.

DYNAMO WINDING.—Can any reader oblige me with the proper winding for an E.P.S. type dynamo of the following dimensions (in centimetres), so as to obtain at 1 ast 4 volts 3 ampères at a speed of about 2000 revolutions per minute:—Length of magnet bar, 11; length of yoke piece, 8·4; width of magnet and yoke piece, 5·3 each; depth of yoke piece, 2·5; thickness of magnet bar inside bobbin, 3; diameter of armature, 5; length, 5·3; air gap, ½ millimetre all round? It has a laminated armature, with 12 interruptions 3/16in. wide by ¼in. deep, and a corresponding number of sections in the commutator. The magnets are of Swedish cast iron. I have tried it with 2000 turns of No. 38 B.W.G. on the field and 120 turns of No. 26 B.W.G. on armature, but can get hardly any current.—E. P. S. TYPE.

FEED PUMPS.—In working out feed pumps for common high-pressure engines, Molesworth says, p. 493—"Take cubic contents of cylinder and one steam passage and multiply by 4, and divide by proper specific volume for given pressure." Why multiply by 4? There are only two cylinders ful of steam discharged to one revolution or one stroke of the pump. Then, again, should not the cubic contents of cylinder be taken to cut off only? For instance, if steam is cut off, say, at half-stroke, and initial pressure be 100lb., the specific volume for which is 2.0, we find a great difference from the plan of taking the full cylinder at the average pressure, which at 100lb. initial pressure will be 75 average, the specific volume for 75 being 353, not to mention the difference in the two cubic capacities. Feed pumps worked out according to Molesworth's rule and others always come out much too large—nearly three times. I shall be glad if some reader will explain this.—COLD WATER.

Replies.

☞ **Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.**

☞ **Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.**

T. DUNKLEY.—There is no mistake.

ENGINE FITTER.—Do you mean a hydraulic motor?

GEARING.—Apply to Messrs. Hadfield and Co Sheffield.

W. T.—Apply to Messrs. Mosses and Mitchell, Chiswell-street, London, E.C., mentioning this journal.

ENGINE DRIVER.—You might apply to the Manchester Ship Canal Company, Spring Gardens, Manchester.

D. J. JONES.—We are unable to give you the information asked for, but will endeavour to obtain particulars for you.

ENGLAND.—See the articles on the subject which recently appeared in these pages. Consult also Reed's "Engineer's Handbook, 12s. 6d.

S. M. O. B.—The celluloid slide rule supplied by Messrs. John Davis and Son, Derby, will best suit you. It is supplied at the price you name.

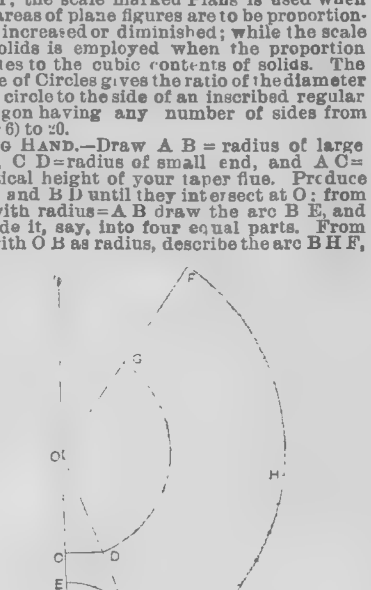
A. J. T.—There is no book dealing specially with the subject, but you will find some useful information in Hugh's "Gas and Gasworks," 4s., which may be had from our office.

CARDIFF.—If you used geared wheels, you would only be able to lift less than ⅓ths of the weight; but if you use plain cast-iron rollers, about 1-12th of the weight would produce slipping. We would advise leather-covered pulleys in place of cast iron.

C. WOODHOUSE.—Full particulars as to the conditions under which Whitworth scholarships are granted will be found in the prospectus, which may be obtained from the Secretary, Science and Art Department South Kensington, London, S.W. Price 3d.

J. PANAMA.—The scale on your proportional dividers marked Lines relates to the direct linear proportion of the openings of the legs. Thus, if the pivot be placed so that the index on it corresponds to the 3 of the scale of lines, the ratio of the openings of the legs will be as 3 to 1; the scale marked Plans is used when the areas of plane figures are to be proportionally increased or diminished; while the scale of Solids is employed when the proportion relates to the cubic contents of solids. The scale of Circles gives the ratio of the diameter of a circle to the side of an inscribed regular polygon having any number of sides from 5 (or 6) to 20.

YOUNG HAND.—Draw A B = radius of large end, C D = radius of small end, and A C = vertical height of your taper flue. Produce A C and B D until they intersect at O; from A with radius = A B draw the arc B E, and divide it, say, into four equal parts. From O, with O B as radius, describe the arc B H F,



and from B set off along this arc sixteen of the equal divisions into which the arc E B was divided. This will give the point F, which connect to O; then from O with radius O D draw the arc D G. The piece B H F G D is the required development. If you require to make a lap joint, you must allow the additional amount required.

LOCOMOTIVE STAY TAPS.—Can any reader furnish me with the addresses of firms who are makers of locomotive stay taps suitable for fireboxes?—GEORGE.—A.—The Patents Company, 153½, Broad-street, Birmingham, are makers of this description of tap, and will submit estimates if you will furnish particulars.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.
Where complete specification accompanies application, an asterisk is suffixed.

17th April, 1893.

7739 PRODUCTION of DESIGNS on WOOD in IMITATION of CARVED WORK. W P Thompson. (*C Bianchi* and *G de S de St. Clément*, Italy.)
7749 ENGINE GOVERNORS. H Aspinall.
7750 AIR TURBINES. L Roze.
7751 AERIAL NAVIGATION. L Roze.
7757 APPLIANCE for OBTAINING MOTION by GRAVITATION and LEVERAGE. C Gill.
7758 ELECTRIC FIRE-ALARM APPARATUS.* E Kloss.
7764 APPARATUS for CONTROLLING the FLOW of GAS PASSING from the GASHOLDERS to the STREET MAINS. F Armitage.
7770 IGNITING APPLIANCE for INCANDESCENCE GAS LAMPS. F Fischer.
7775 OIL PRESSES. A Armand and B Hilaire.
7780 OIL CANS. R H Bishop.
7782 ELECTRIC CABLES. G G M Hardingham. (*The Firm of Felton and Guilleaume*, Germany.)
7783 FANS for MINES and SMITHS' FORGES.* G Hanarte.
7785 ANCHORS. H F Hiron.
7789 RAILWAY SPIKES.* S H Bracey and F H Blodgett.
7791 PREPARATION of IRON or STEEL PLATES for NICKEL or OTHER PLATING. C T J Oppermann.
7792 PILES, BLOOMS, and BILLETS of IRON or STEEL. W Hayward, sen.
7796 METHOD of BENDING METAL PIPES. G Oesten.
7798 FOUNDATIONS of ENGINES and OTHER MACHINERY. J Eaton-Shore.
7801 APPARATUS for GENERATING STEAM by the AID of HOT or MOLTEN SLAG from SMELTING FURNACES. J Howell and E A Ashcroft.
7802 AIR COMPRESSORS.* A J Boult. (*G Hanarte*, Belgium.)
7803 AIR PUMPS. H and F Schulze-Berge.

18th April, 1893.

7806 PORTABLE TELEPHONES. G L Anders and W Köttgen.
7807 STEAM and GAS ENGINES. W N Hutchinson.
7812 APPARATUS for MANUFACTURING WIRE RODS. W Ambler and J H Broomhead.
7813 COMBINED CROSS-GROOVING and STOP-GROOVING PLANE. A Lowe.
7827 MECHANISM for SETTING-UP and AUTOMATICALLY ADJUSTING the PRESSURE UPON the BRASSES of ECCENTRIC SHAFTS. J Appleby.
7829 FILE-CUTTING MACHINES.* J Béché, jun.
7836 CAR STARTER and BRAKE. H Duys.
7842 TOOL for MAKING MEASURING SCALES on DRAWINGS and MAPS. W P Thompson. (*L Moll*, Germany.)
7843 WRENCHES.* J A Barker.
7844 APPARATUS for INDICATING and REGISTERING the SPEED of MARITIME VESSELS.* W P Thompson. (*C F Holt* and *W S Starr*, United States.)
7845 COMBINED CAR and AIR-BRAKE COUPLINGS.* W Mable.
7849 MACHINERY for PRESSING BOATS from SHEET METAL. W Heslop.
7855 CAR COUPLINGS.* R R Wilson.
7860 STEAM TRAPS. W Geipel.
7863 APPARATUS for COMPENSATING for the EXPANSION and CONTRACTION of RAILWAY SIGNAL WIRES. A G Evans.
7864 STEAM BOILERS.* M L Severy.
7865 LIGHTNING ARRESTERS and DISCHARGE PROTECTORS.* E Thomson.
7866 LIGHTNING ARRESTERS.* E Thomson.
7867 ELEVATED RAILWAYS.* H H Lake. (*G F Brott and others*, United States.)
7869 MECHANISM for the APPLICATION of HAND POWER in TOOLS and MACHINES.* E Liebing.
7870 METHOD of PURIFYING WATER or CONTAMINATED WATER.* H Krieg.
7871 MOTORS. J Atkinson.
7872 MOTORS. J Atkinson.
7880 ROPE CLIPS or GRIPPERS for ATTACHING VEHICLES to HAULING ROPES. J Ramsay.

19th April, 1893.

7887 MECHANISM for AUTOMATICALLY STARTING TRAMCARS by MEANS of COMPRESSED AIR. W Evans.
7890 ADJUSTMENT and SINGLE or DUPLEX INDICATOR for STEAM or COMPRESSED AIR NOZZLES. A E Hubert and W Edwards.
7893 JUNCTIONS for UNDERGROUND CONDUITS for ELECTRIC WIRES. J Patterson and J Shaw and Co.
7896 IMPROVEMENTS in the CONSTRUCTION of SHIPS to PROVIDE MEANS for SAVING LIFE. J Kenney and C Forrest.
7897 GALVANIC BATTERIES for UTILISING the WASTE. W Jones.
7898 STEAM VALVES. B Whitehead.
7912 PUMPS for PUMPING or COMPRESSING GASES or VAPOURS. T R Murray.
7913 AUTOMATIC SECTION GUARDING SIGNALLING APPARATUS. H N Hillman and G Childs.
7923 STEAM GENERATORS. P M Justice. (*La Société Anonyme du Générateur du Temple*, France.)
7925 CRUSHING MACHINERY. T Thompson.
7926 MILLS for CRUSHING and GRINDING. W Duffield and W R Taylor.
7927 METHOD of BRINGING MINERAL TRUCKS from PLACE of DISCHARGE to PLACE of FILLING WITHOUT UNHOOKING or STOPPING ONWARD MOTION.* C McAllister.
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7930 LOCK-NUT and BOLT.* J H O'Brien.
7932 COUPLING for CONNECTING the SPINDLES of AXLES of RINSING MACHINES with REVOLVING SHAFTS. J Wetter. (*O Steibelt*, Germany.)
7935 ARC ELECTRIC LAMPS. E V Buchet.
7941 JOINT for EARTHENWARE, STONEWARE, and METAL PIPES. B Paddon.
7942 HOT AXLE-BOX DETECTORS.* A V Newton. (*The Kerr Thread Company*, United States.)
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7948 PROPULSION of VESSELS. W H White.
7952 RATCHET BRACE. A Taylor.
7955 HAND PLANES.* G Leadbetter.
7958 TREATMENT of TOWN'S REFUSE. H B Ransom.
7959 SHIPS' PROPELLERS.* A T Elford.
7960 GAS or OIL ENGINES. A J Boult. (*Léon Heinen*, Belgium.)
7931 WIRE-DRAWING MACHINES.* C H Hagg and others.
7963 FURNACES.* H Peterson and C Kromphardt.
7964 PICKS. W Owen and W K Birkinshaw.
7966 CHAINS. E Kollmar.
7967 MIXING MACHINES for FLOUR and OTHER PULVERULENT MATERIAL.* R Hartmann.

20th April, 1893.

7968 IMPROVED FUEL. W L Malcolmson.
7970 VALVES and FITTINGS for INFLA BODIES. H E Bodley and S H H Barratt.
7979 RAILWAY SIGNALS. W Pearson.
7980 CONNECTING RODS for SINGLE-ACTING ENGINES. E G Guyot.
7984 APPARATUS for LOCKING the HOME SIGNALS on RAILWAYS. H Parkinson.
7985 APPARATUS for DISCHARGING ASHES from STEAMBOATS. J J Galloway.
7991 PREPAYMENT MECHANISM, APPLICABLE to GAS and ELECTRICITY METERS. S Simpson.
7993 HIGH-SPEED STEAM ENGINES.* W E Heys. (*C Brown*, France.)
7999 MACHINERY for USE in TUNNELLING. R Jenkins. (*E C Jenkins* and *F A Willett*, Mexico.)
8004 ELECTROMOTORS APPLICABLE to the PROPULSION of VEHICLES. E D Pass. (*M Johannet* and *G Dupont*, France.)
8006 APPARATUS for EMPLOYMENT in AUTOMATICALLY FEEDING METAL SHEETS BETWEEN the DIES of CORRUGATING MACHINES. E P Jones.
8010 GAS BURNERS and STEAM GOVERNORS. E Neuff and G W Quin.
8017 ROAD ROLLERS. F J Burrell.
8019 GRINDING MILL. J G Mole.
8020 ATMOSPHERIC VACUUM ENGINES. J Kenapper and S B Marton.
8024 HEAT and WIND MOTOR. A R Bennett.
8031 CISTERN VALVES. J Gerrans.
8035 ELECTRO-PLATING ALUMINIUM. H D Cunningham.
8038 CAR COUPLING. M L Cable and J C Walton.
8040 IMPROVED FUEL. D W Nightingale and S G Wicking.

21st April, 1893.

8046 RADIATING HOT-AIR HEATING APPARATUS. W N Rudge.
8057 MANUFACTURE of IRON and STEEL. A Sattmann and A Homatsch.
8075 SCREW PROPELLERS. G Chapman.
8087 ARC ELECTRIC LAMPS. J Brockie.
8088 PIPE CUTTERS. O Riga.
8094 REFUSE DESTRUCTORS.* H E Newton. (*B R Harrington*, India.)
8095 IMPROVEMENTS in WORKING MOTIVE-POWER ENGINES. A Morcom.
8100 GOVERNING STEAM ENGINES. M H P R Sankey.
8102 EXERCISE or AIMING TUBES for GUNS. E W Lloyd and A G Hadcock.
8014 PULLEYS or RIGGERS and WHEELS. J Melling.
8106 HYDRAULIC LIFT MACHINERY. R F Carey.
8108 BUCKLES and CLIPS for FASTENING BELTS and BANDS.* D Pasztor.
8112 BALLS or ROLLERS. E M Fox.
8113 LIFTING and HAULING APPARATUS. A Mack.
8114 PREVENTING CORROSION of PROPELLER SHAFTS.* J E Taylor.

22nd April, 1893.

8119 VALVE MECHANISM of STEAM or OTHER FLUID-PRESSURE PUMPING ENGINES. W Cameron.
8130 POSITIVE SELF-REVERSER for MACHINES HAVING a REVOLVING SHAFT WHOSE DIRECTION of ROTATION is to be CHANGED. W H Riddlesworth.
8131 APPARATUS for HEATING FEED WATER. R S Brownlow.
8140 GAS and other HYDRO-CARBON ENGINES. W E Simpson.
8141 METHOD for THROWING CRANKS OVER CENTRES. H Lewis.
8146 HOT-WATER BOILERS. D S Keith.
8153 ATTACHING and DETACHING GEAR for SHIPS' BOATS. C J Guthrie.
8156 STOP COCKS or TAPS. M Sellier.
8158 ADMISSION VALVES for PATROLEUM or SIMILAR MOTORS.* J T Lindahl.
8163 MINERS' ELECTRIC SAFETY LAMPS. E Bailey and G Mortimer.
8174 TRAMWAY CARS. A Currie.
8185 PROPULSION on LAND and WATER. R Stone.
8187 MINERS' SAFETY LAMPS. H L Mann.

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FRIDAY, MAY 12TH, 1893.

Improvements in Railway Signalling.

AN automatic-signalling system for railways is now being tested on a line of railway in the Isle of Wight, the signalling being effected by means of short lengths of depressible rails, which are acted on by the flange of the engine wheel in passing along the line, the normal condition of the signals being danger. There are two depressible rails at each signal station, one of which places the signal at danger, while the other causes the signal at the previous station to show line clear. The first rail is connected up with a contact breaker, and the second with a contact maker. The engine on passing two block stations places the signals of both at danger, and on arriving at a third it depresses the rail connected with the contact breaker, the upper part of which is insulated, thus breaking the electric circuit. The effect of this is to release the tongue of the two relays, one of which controls the local circuit and allows the signal arm and spectacle to fall by gravity to danger. Immediately after this the train depresses the rail connected with the contact maker, thus completing the electric circuit through the upper part of the contact maker, which is of brass, through the relay, the line wire battery and the local relay, to earth. This causes the armature of the local relay to be attracted, and thus places the first signal at clear. As the contact made by the contact maker is only momentary, the relay is so arranged as to cut it out when the circuit is completed and to introduce a fresh earth. The mechanism for actually moving the signal arm and spectacle is contained in the signal head.

The Incandescent Lamp.

THE validity of the Edison patent for the incandescent lamp has been contested for several years in the United States, and has led to much litigation. The contending parties have been the owners of the Edison patents and the Westinghouse Electric Company. The decisions in this litigation, both in the Circuit Court and in the Court of final resort, the last rendered in August, 1892, sustained the Edison patent. As a result of this, the Edison Company, on the supposition that no opposition would be made, applied for and obtained injunctions against some of the smaller lamp manufacturers, and several works were in consequence closed. It seemed as if the Edison Company were determined to shut down all the lamp factories belonging to what are termed the outsiders. This was, however, not to be permitted without protest. The Beacon Company, of Boston, on the Edison Company asking for an injunction against them, opposed the motion, and presented evidence showing that the incandescent electric lamp was invented and put in public use by H. Goebel some years before Edison or any other inventor attacked the problem. The result of this application was the granting of an injunction on the ground that the evidence supporting Goebel's claim to be the original inventor was insufficient. On, however, attacking the Columbia Incandescent Lamp Company, the Edison Company met their match. Additional evidence in favour of Goebel was advanced, and after being thoroughly argued on both sides, a preliminary injunction was refused on the 20th ult. This is the first action towards declaring Edison's patent to be invalid, and the importance of the decision is very great, not only to lamp makers, but also to electrical interests everywhere. This is, of course, merely the first step in what promises to be a hard-fought battle. The preliminary injunction being refused, the case must now be heard on its merits in the Circuit Court, and afterwards probably in the Court of Appeal. In the meantime, the Columbia Company and other makers, against whom injunctions have not been secured, will go on with the manufacture; and even in the event of the Edison Company obtaining a final victory, the delay in getting it will be such that the patent will then be at or near the end of its life—namely, in November, 1894.

The Yeardon Revolving Retort.

A NOVEL form of gas retort has lately been brought before the gas-producing community as one which is expected to revolutionise the process, and to considerably reduce the cost of gas manufacture. The retort, about 7ft. of which is exposed to the fire, is conical in form and made of cast iron, revolving about three turns per minute on a horizontal axis. The diameter of the heated part is about 2ft. 6ins. at the feeding end and 3ft. 6ins. at the discharging end. There are four feathers cast solid with the retort, which in revolving constantly keep the coals stirred. An external ring rib is cast on to strengthen the body of retort which is exposed to heat. There are stuffing boxes with asbestos packing in the stationary part at each end. Means are also taken to prevent in-draught of air into the furnace by having segmental strips of iron close to the revolving retort. Plain rollers revolving in the water trough castings support the retort at the feed end, while at the discharge end the rollers are V shape to keep the retort in its position longitudinally—the expansion caused by the heating taking place at the feed end, where provision is also made in the driving pinion being made more than double the width of the wheel attached to the retort. The stuffing box at the feed end is also elongated to allow of expansion and jets of water being played on the packing for cooling and lubrication. At the feed end a hopper is kept constantly full of coal, which in turn is forced into the smaller end of the retort by blades fixed spirally on the shaft. The coal drops from the end of a pipe into the retort, which, being conical and revolving (with internal feathers), is made to travel automatically to the large end, where the cinder falls into a recess, from which it is discharged by similar spiral blades. The coal can be automatically fed by conveyors into hoppers, and the cinder taken away by similar conveyors. The gas produced is then taken off at the large end of the retort by the usual exhauster arrangements, the vacuum inside the retort being regulated so as to prevent the possible escape of gas or indraught of air. The closely-packed coal at the charging end, and the similar tightness of the cinders keep the retort practically closed, if there is not too great a variation caused in the range of vacuum by exhausters.

A New Explosive.

UNDER the name of "Maximite," a new explosive has just been tested in New York. It is a nitro compound, the base being gun-cotton, but the ingredients and process of manufacture are a trade secret. The inventor, Mr. Hudson Maxim, has been experimenting with smokeless rifle powders for four years, making a speciality of nitro compounds. In these experiments he found that the compound could be made so cheaply that it could compete with dynamite, and he could therefore make with the gun-cotton a smokeless explosive for blasting. The tests with this explosive have been in progress for a year, and the material is now manufactured and costs no more for the same amount of work than dynamite. It is claimed that 10oz. of maximite are equal in effect to 1lb. of 40 per cent. dynamite. A special feature of the explosive is that it is unfreezable. It is also claimed that one cartridge cannot be exploded by the explosion of another standing beside, but not touching, the first; that the material is difficult to set fire to, and that it cannot be exploded by striking with a hammer; whilst a temperature of 400° F. is required to explode it by direct heat.

The Giffard Gun.

SOME time since, a new gun, the invention of M. Paul Giffard, of injector fame, was introduced, and attracted some attention, owing, in a measure, to the fact that the propulsion of the bullet was effected by carbonic-acid gas. Recently the weapon has been modified, both in detail and construction. The principle, however, is the same. The new gun is 3ft. 9in. in length, with a hexagonal barrel, having a 0·295in. bore, and weighing 6lb. The liquefied gas is contained at a pressure of two tons per square inch in a steel tubular reservoir 9in. in length, fixed under and in a line with the barrel of the gun, the combination producing a very handy and well-balanced weapon. In charging the gun, a lever, which forms the trigger-guard, is lowered. This opens a chamber for the insertion of a conical bullet, cocks the gun, moves an indicator which shows the charges expended, and places the gun at "safe." When the lever is returned to its normal position the bullet chamber is closed, and the bullet placed in line with the barrel. The safety catch is released by the thumb, and when the trigger is pulled, the tumbler strikes a discharging pin. This actuates the valve of the reservoir, which it momentarily opens, causing the emission of a charge of gas. The gas expands in the bullet chamber, and drives the projectile before it through the barrel. It is claimed for this gun that it is practically noiseless, and entirely smokeless, has little or no recoil, and does not foul.

Electric Buoys.

A SYSTEM of electric buoys has now been in operation for about a year to mark the "swash channel" at Sandy Hook, and has given good results. This method is now being adopted on Lake Michigan in connection with the Chicago Exhibition. The peculiar situation of the Fair grounds in relation to the city of Chicago necessitated unusual facilities for transporting visitors passing from the city to Jackson Park, and in order to assist in dealing with the traffic it was decided to run a line of whale-back steamers from Chicago to the Casino wharf at the Fair grounds. The buoys, of which there will be 13, located at intervals of half-a-mile, will allow of the traffic being readily handled at night, the steamers running up one side of the buoys and down the other. The head of the buoy is equipped with a 100C.P. lamp arranged in a cage, which also contains a transformer; and the connections of the cables are carried in slots sunk in the sides of the buoy and covered with strips of wood screwed tight. The chief point of novelty in the system is the fact that the buoys will be worked in series by an alternating current of 1460 volts, and the submarine cable will be 14 miles long. The buoys are to be set in operation early in June. Naval officers of the United States and of other Governments have been favourably impressed with the installation at Sandy Hook, and the Chicago buoys will afford opportunity for gaining further experience in the illumination of ports and waterways generally.

Small Copper Castings.

GREAT difficulty is usually found in making small castings of copper, owing to the rapidity with which oxidation proceeds when the liquid metal is exposed to the air, as it is when poured into a mould. Moreover, as well-known experiments have shown, the strength of copper is singularly affected by the presence of small quantities of dissolved cuprous oxide; and it becomes absolutely necessary, in studying the effect of single elements upon copper, to exclude the simultaneous presence of cuprous oxide. To attain this object, Professor Roberts-Austen, in the experiments dealt with in the "Second Report to the Alloys Research Committee," adopted a method suggested by Mr. Jenkins, in which the molten metal was not brought into contact with the air, but the moulds formed part of the crucible in which the metal was melted. Tubes were first prepared by drilling out long rods of electric-light carbon from one end, a certain thickness of solid material being allowed to remain at the opposite end, through which a fine hole was subsequently made. Pure electrolytic copper was used; the weighed amount of this was placed in a crucible sufficiently large to leave an inch of its height to spare beneath the plug or lid into which the tubes were fixed. Seven tubes were usually employed for each set of castings made to undertake the tests. The carbon tubes, with their open ends downwards, were placed vertically in the centre of the crucible and packed in with fireclay; the whole were carefully dried, and when ready were placed in a furnace with a deep fire. When the copper was thoroughly melted the crucible was lifted out and then inverted, so as to cause the copper to flow into the carbon tubes. A little copper was allowed to flow out of the fine holes in the outer ends of the tubes, and these holes were then stopped by placing the tubes upright in a bath of sand. In casting the bars containing impurity, a rich alloy of known composition was made in the first instance, and a weighed amount of this alloy was added to the charge, which latter was well shaken when melted. After having been hammered, heated, and quenched, the pure copper rods were tested. Several sets of copper castings were analysed and were found to be singularly pure, containing 99·99 per cent. of copper. Although carefully sought for, neither lead, silver, antimony, arsenic, tin, iron, nickel, sulphur, nor phosphorus could be detected, but a minute trace of bismuth was discovered. The electrical conductivity of this copper after annealing was found to be very high, proving to be 102, whilst pure copper is generally 100 or 101.

On Testing Machinery and Electric Water-level Recording Apparatus.

(*Continued from page* 178.)

Apparatus for Testing Air Valves.—It may be necessary to explain that automatic air valves are placed on waterworks mains, to allow of the air being discharged when filling the pipe, and subsequently to continue to discharge small quantities of air that may collect when pipes are under

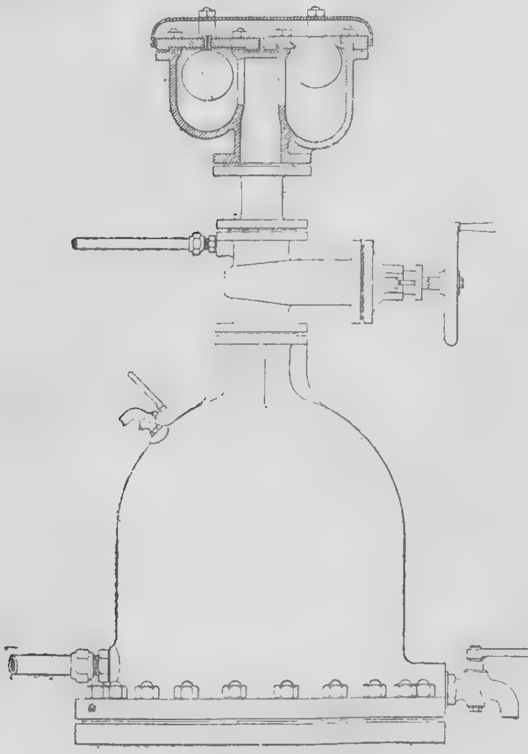
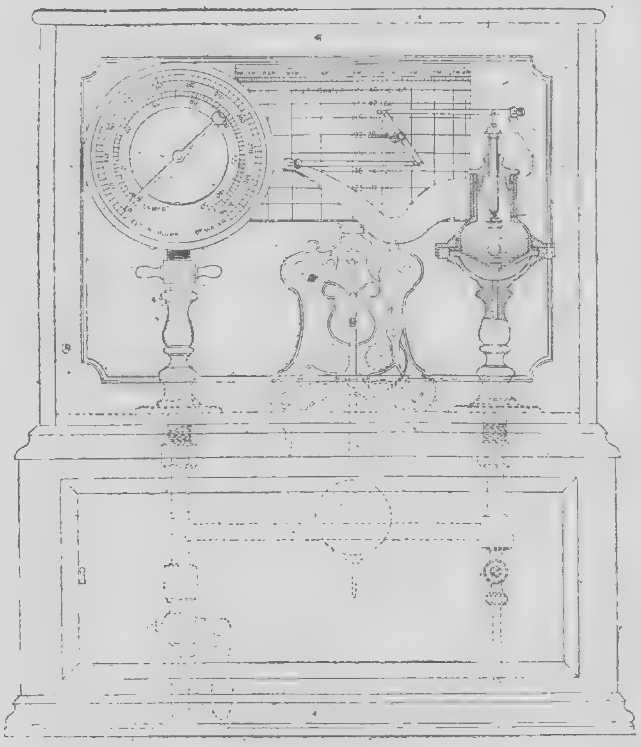


Fig. 6.



Testing Machinery, etc. Fig. 8.

pressure. These air valves are placed on the summits of the pipe line, and they also serve to admit air when pipes are emptied. It is to test the air valves under actual working conditions that the apparatus (Fig. 6) is used. The sluice valve which establishes communication between air valve and charging vessel is closed. Suppose the air valve is to be tested for automatically discharging air under 300lb. per square inch. The body of the air valve is charged to that pressure by a small upper pipe connection, the charging vessel underneath the sluice valve previously empty (or full of air at atmospheric pressure) being charged to the same pressure at the same time. When the pressure indicates 300lb. above and below sluice valve, it is then opened, thus establishing communication. The air which was imprisoned in the charging vessel now finds its way up into the air valve, when the ball in the chamber which has the small orifice, falls, and discharges the imprisoned air, floating up and closing the orifice after the air is discharged. It is a curious fact that if a sieve or perforated plate be interposed at the inlet to air valve, the air will not rise through it, nor be discharged.

Tap Testing Apparatus.—The pressure for tap testing in the works is supplied by the three throw pumps previously referred to. The illustrations Fig. 7 show the hand pump that is used for this purpose by waterworks testing houses, and consists of a weighted lever resting on a plunger, giving the test pressure necessary—usually 300lb. per square inch. The nipples, etc., shown, are suited to receive and test stop and bib taps, screwed ends or plain ends of all sizes up to 1½ or 2in. diameter.

The gauge is carefully graduated and dial marked from mercury column.

Other Testing Instruments.—King's pipe calipers are used for testing thickness of pipes or cylinders, and have a reach of 5ft.

A small mercury column is used for showing to the testing machine attendants the depth of water in overhead cistern.

The U-shaped water gauge is used for showing pressure of blast to foundry cupolas.

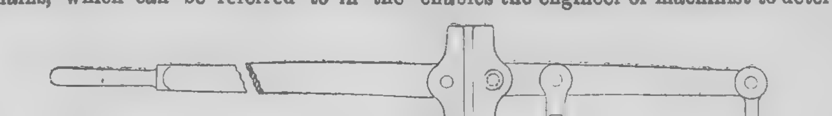
A set of Whitworth standard male and female mandril gauges is used for diameters, and male and female gas thread Whitworth gauges used to ensure accuracy in these. It would be beneficial if our tube makers were to work more rigidly to Whitworth standard than they generally do.

Measuring tanks, with graduated scales, are used for testing water meters, which are all accurate to within 1 per cent. before being sent out. Special arrangements of heavy flanges and bolts are used for testing hydraulic cylinders, rams, etc. The usual test pressure for a 700lb. working pressure is 2500lb. per square inch.

Pressure Recorders.—The pressure acts upon a volute spring, having an indiarubber diaphragm beneath. The motion is communicated to pencil or pen, that marks on diagram by an upright spindle, acting through the ordinary form of parallel motion. The clock drum revolves once in 24 hours, or once a week if desired. A pressure gauge, on the Bourdon principle, is usually fixed alongside, as shown in Fig. 8.

The disc and spring arrangement lasts a long time, and a disc is easily replaced. It is not quite so sensitive as the Bourdon spring, but sufficiently so to give a reliable record of the pressure in water mains, or in steam pipes. It is very important to have a record of pressure in the water mains, which can be referred to in the event of a heavy consumption, say on account of a fire. If a burst occurs which is at all serious, it immediately shows on the diagram by a reduction of pressure. The instrument is sometimes fitted with an electric alarm bell, to give an alarm in the event of the pressure being reduced below a certain figure. For low pressures, the disc and diaphragm arrangement is sometimes replaced by a mercury column widened out at one end, and carrying a float, to which the pencil is fixed that marks the diagram.

(To be continued.)



Testing Machinery, etc.—Fig. 7.

Mechanical and Engineering Drawing.—XII.

By a Practical Draughtsman.

Orthographic Projection. — A careful study of the preceding articles, VI. to XI., and the solution of the problems contained in the two last, will have prepared the student for entering upon that more important part of our subject—viz., "Orthographic Projection," or that special kind of delineation which, when applied to the representation of mechanical subjects, enables the engineer or machinist to determine at sight the actual dimensions and arrangement of any part of an engine or machine. As, however, a *part* of a piece of mechanism is but a compound of simple forms made up of what are known as plane solids and solids of revolution—alone or combined,—it is at once manifest that to be able to draw any part of a machine, the would-be draughtsman must first master the delineation of its component parts, and as these resolve themselves into solids, with either plane or curved surfaces, having straight or curved lines for their boundaries, the question of their ultimate accurate representation as a whole becomes one of the *correct projection* in the first stage of the study, of the lines bounding the *surfaces* of solids; and as straight lines and flat surfaces are more easy of projection than curved ones, we commence this part of the subject by an illustration of its principles in the projection of points, straight lines, and the simple figures which form the surfaces of those plane solids used in giving shape to machine and engine details.

By a reference to the latter part of Article VI., page 68, it will be noted that to obtain the views of an object required for the purposes of manufacture its projections are determined on two planes, at right angles to each other—that is, their relative positions are as shown in Fig. 13; that lettered V P being a plane assumed to be vertical, and the other H P a horizontal plane perpendicular to V P. These two planes are called the *vertical* and *horizontal* "planes of projection," and will throughout the exposition of the subject of "projection" be denoted by the letters V P and H P.

The student should be particular to note the precise difference of meaning existing between a "vertical" line or plane and one that is "perpendicular." One line or plane may be perpendicular to another line or plane, and yet neither of them be vertical. A *vertical* line is a plumb line, or the position a weighted line assumes when freely suspended. A *horizontal* line is one which is parallel to the horizon, and, therefore, perpendicular to a vertical one. A "vertical plane," then, is one with which a plumb line will coincide, and similarly a "horizontal plane" is one parallel to the earth's surface *taken as a plane*, and is at right angles to the vertical.

A *plane*, strictly defined, is nothing more than a perfectly flat "surface," without any reference to *substance*; but as it cannot be dealt with for explanatory purposes without being assumed to be material and inflexible, it will, when spoken of, or used for that purpose in these articles, be considered as having such a thickness as would be represented by a line. Assuming this, the *edge* view of a plane will, under any circumstance of position, be a perfectly straight line. If, then, two planes *intersect* or meet each other at an angle, as the "planes of projection" we are about to deal with do, their meeting will be in a line, which forms a boundary or dividing line between them, and is called the "intersecting line" of the planes. This line will throughout the subject have I L for its distinguishing letters.

Knowing, then, the true relative position of the "planes of projection" on which we wish to obtain the representation of an object, we will first proceed to find the projections of a "straight line" in different positions with respect to those planes. Let its position at first be perpendicular to the V P.

Here, as the thing to be projected is a "line" having ends or points, before we can obtain its projections we must first know how to find those of a "point." Let, then, A in the diagram Fig. 70 be a point in space, such as a small bead invisibly suspended, and let it be required to find its vertical and horizontal projections—that is, its projections on the V P and H P?

To obtain these, we have to find the points in the V P and H P where a visual ray or projector perpendicular to each of the planes, and drawn through A, would penetrate them. This, it will be seen in the diagram, is in *a* in the V P, and *a'* in the H P, and therefore *they* are the required projections, *a* being an *elevation* or vertical projection of A, and *a'* its *plan* or horizontal projection. If it were required to find *from* its projections the *position* of the original point A with respect to the V P and H P, then perpendiculars to those planes let fall from its projections *a* and *a'* would intersect in A, giving it as the position of the original point.

Knowing how to obtain the projections of a point, we shall now be able to find the projections of a straight line.

1st. Let the line A B, Fig. 70, be perpendicular to the V P?

Here A B being perpendicular to the V P, will be parallel to the H P; therefore, from its position with respect to the V P, its projection on that plane will become a point *a*, as the eye being directly opposite the end of it, the visual ray or projector proceeding from the eye will travel along the line itself, coinciding with it, and penetrate the V P in *a*, then *a* is the "elevation" of the line A B. To find its "plan" or projection on the H P, let fall projectors perpendicular to the H P from both ends of

A B, and the points a' b, where these projectors penetrate the H P, will be projections of the ends A and B of the line A B, and if a' b be joined, then a' b will be the plan or horizontal projection of the original line.

2nd. Let C D (Fig. 70) be the given line, and let it be perpendicular to the H P, and its projections required?

In this case C D is parallel to the V P, and its projection on that plane will be obtained by letting fall from C, D its ends, projectors to the V P, and the points c d, where these fall on that plane, will be the vertical projections of C and D in it; then, if c and d be joined, c d is the elevation of the line C D. As the given line is perpendicular to the H P, its plan will be a point obtained by producing a visual ray passing through and coinciding with C D itself, until it penetrates the H P in d'.

3rd. Let E F be the given line (Fig. 70), and let it be parallel to both the V P and the H P, and its projections required?

Here E F being parallel to both planes, by letting fall projectors from E and F to the V P, we obtain points e and f, and to the H P points e' and f', then e f and e' f' being joined will be the required projections. It will be noted here that the projections of the original line E F are two lines of the same length as their original. This is owing to the relative positions of the original line, and the planes on which its projections were required. Had the line been in any other position with respect to those planes, a different result would have been obtained, as will be seen by the following problem.

4th. Let G H be the given line, and let it be parallel to the V P, but *inclined* to the H P, and its projections required?

Here G H being parallel to the V P, its vertical projection or elevation is found by letting fall projectors from G and H to the V P, giving points g and h, which, when joined, will be a line of the same length as G H; but its horizontal projection, obtained by letting fall projectors from the same points G and H on to the H P, giving g' h', will be found to be projected into g' h', a much shorter line than its original.

The diagram Fig. 70, the student must note, is drawn in what is known as "quasi-perspective," and is adopted as a simple and ready means of showing the two planes of projection in their relative positions, and the positions of the lines given in the foregoing problems in relation to those planes. It is in no sense an othographic projection diagram, although used to explain the application of the principles of that kind of projection.

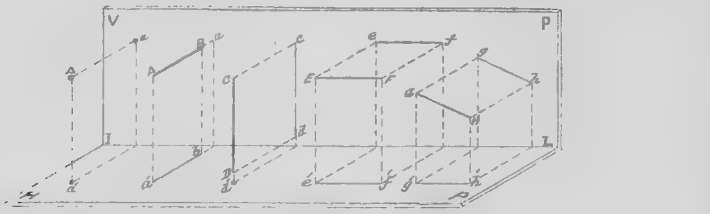
To convert the actual relative positions of the two planes of projection, as shown in the diagram Fig. 70, into the positions they occupy on the sheet of drawing paper when laid on his board, the student has to suppose the "upper" plane, or that we have named the V P, turned backwards on the I L (intersecting line) as a hinge, until it is on the same level with the "lower" one or the H P, the two planes thus becoming one flat surface, as in Fig. 71, with the I L dividing them, and the plans and elevations of the lines in the problems shown on them as obtained by projection.

Assuming that the student has found no difficulty in understanding the explanations already given of the way in which the projections of a line when it is in either of the suggested positions, with respect to the planes of projection, are obtained, there are yet two other positions that a line may occupy with respect to those planes, whose projections we must know how to find before we can proceed with the projection of plane figures. One of those positions is that of a line inclined to *both* the V P and the H P. We have shown, in Figs. 70 and 71, that if a line be parallel to one plane and inclined to the other, its projection on the plane to which it is parallel will be a line equal in length to the original, and on the one to which it is inclined its projected length will depend upon the angle the given line makes with its plain of projection. This will be made still clearer by the demonstration of the problem where:—

5th. A line A B is inclined to both the V P and H P, and its projections are required (Fig. 72)?

Let the given line at first be parallel to the V P, and perpendicular to the H P. In this position its projection on the H P will be a point, as a, and on the V P a line A B, at right angles to the I L. While keeping A B parallel to the V P, conceive it to swing round to the right on A as a joint, until it makes any desired angle with the I L; or say until B has moved into the position b, its elevation b A in this position is a line inclined to the I L, of the same length as A B, but its plane, obtained by letting fall from b a projector perpendicular to the H P, or I L, in c, gives a c as its projection on the H P, or a line less than half the length of its original. It is evident from this that the *projected length* of a line is entirely dependent upon its angle with the plane of its projection, for if the motion of the line A B in this case were continued until it coincided with the I L, its projected length a d, and its original length A B, would then become equal.

But so far the given line is only inclined, as at A b, to *one* of the planes of projection, the H P; for although we have moved it from its assumed first position—that is, perpendicular to the H P—to that of making an angle b A D with it, it is still parallel to the V P. Let it also be inclined to that plane, say 45°. For distinctness, let C be a new position of A on the I L; at C draw C t, at an angle of 45° with the I L and equal to a c, or the projected length of A b in the H P; then C t will be a plan of A b when at 45° to the V P, and at the angle b A D with the H P. To obtain its elevation, draw from t a projector perpendicular to the I L, and from b another parallel to it, to cut the one from t in p, join C and p, and the line C p will be the elevation of the original line A B, inclined to both planes of projection. Here it will be noticed that the original line A B, in addition to its having been moved on A as a joint from B to b, has also, while making the angle b A d with the H P, been swung round on A through 45°.



MECHANICAL AND ENGINEERING DRAWING.—FIG. 70.

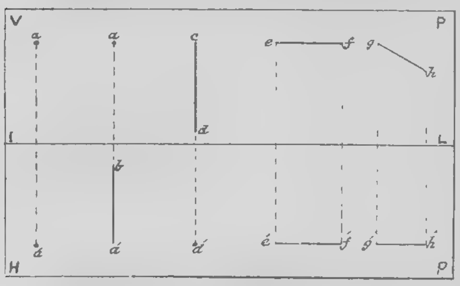
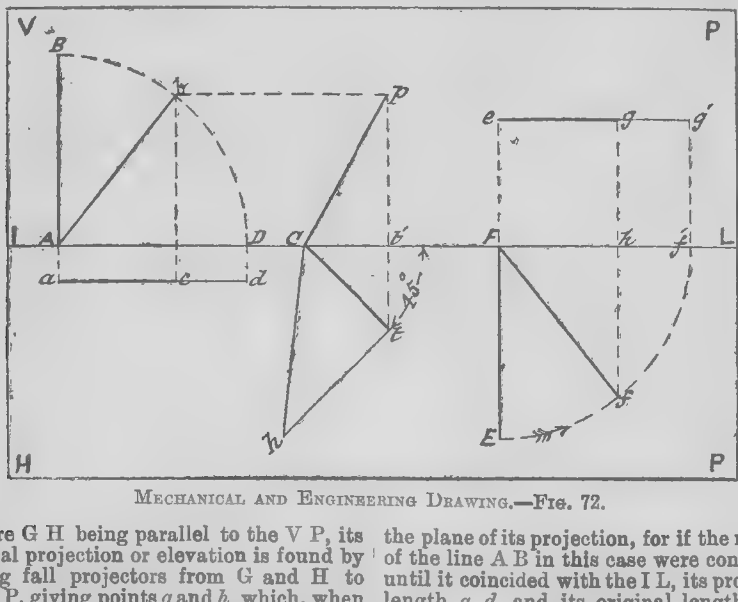


FIG. 71.



MECHANICAL AND ENGINEERING DRAWING.—FIG. 72.

Now to make this matter of the projection of inclined lines still more clear, as much depends on the student having a thorough grasp of this first part of the subject. We will assume that the two projections, C p in the V P, and C t in the H P, are *given*, and it is required to find the *real length* of the line of which they are the projections.

Here the line C t is the plan or horizontal projection of the line C p, the latter being a line having *one* of its ends C, *in* the H P, and the other end p a given distance *above* that plane. C p is also the projected length of the hypothenuse (or longest side) of a right-angled triangle, having C t for its base, and a line equal to the vertical height of p from the H P for its perpendicular. With these two sides given, we can find the third side, or the actual line of which C p is the projection. Therefore, at t in the line C t, and perpendicular to it, draw a line indefinitely, and from it cut off in h, a length t h equal to the height that p in the line C p is above the H P or I L, join C and h; then C h is the real length of the original line, of which C p and C t are its projections. This is self-evident, for if the right-angled triangle C t h, which may be assumed to be lying on the H P, with its base line coinciding with C t, be raised to a vertical position, moving on C t as a hinge, its base and hypothenuse will then be coincident with C t, and its third side h t is a vertical line perpendicular to the H P represented by the point t.

The other position a line may have, with respect to the planes of its projection, is that of being parallel to the H P, but making an angle with the V P. Putting this in the form of a problem, we will say—

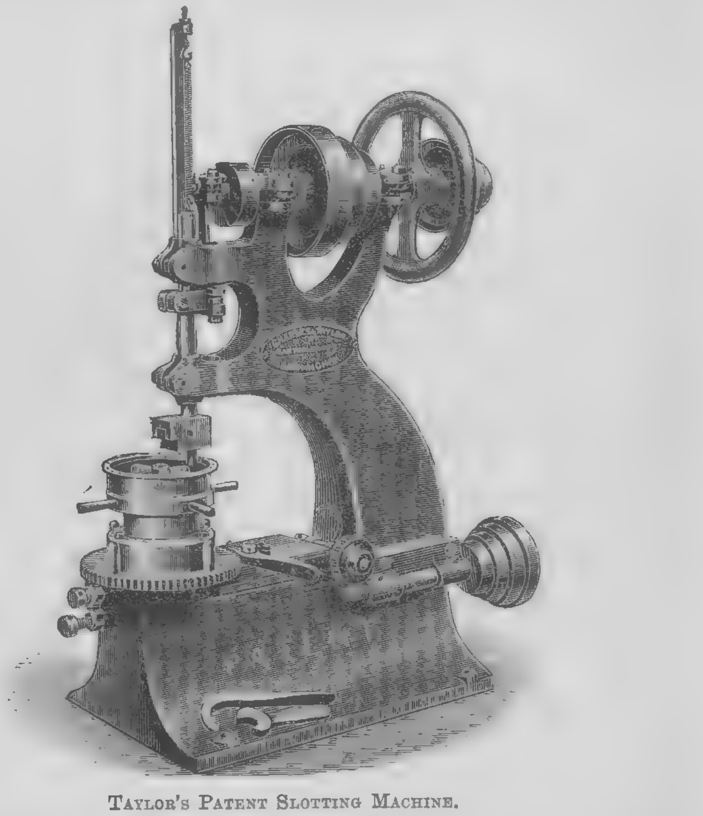
6th. Let a given line be parallel to the H P, but inclined to the V P, and its projections required?

In this case let the given line at first be perpendicular to the V P; its elevation when in that position in the V P will be a point as e, and its plan a line E F at right angles to the I L. But as E F is perpendicular to the V P it is parallel to the H P. While keeping it so, let it be conceived to swing on its end F as a joint in the direction of the arrow, until it makes any desired angle with the V P or I L, or until, say, E has moved into the position f; its elevation in that position is found by drawing a projector through f, perpendicular to the I L, and a line through e parallel to it to cut the projector from f in g, then the line e g is the vertical projection of E F when making the angle L F f with the V P. Here it is again seen that the projected length of a line, although parallel to one of its planes of projection, is determined on the other plane by the amount of its inclination to that plane; for had the given line E F in this case been moved through any greater or less angle than the one assumed in the diagram, its projected length in the V P would have been greater or less than e g, directly in proportion to its altered position with respect to the V P. If E F had been swung so far round on F until it had coincided with F f', then its projection in the V P would be e g', or a line equal in length to the given line E F.

(*To be continued.*)

Taylor's Patent Slotting Machine.

THE illustration herewith is of an automatic machine for cutting the internal gear of the hubs of the type of bicycle known as the geared ordinary. As will be seen, the machine is in the form of an upright slotting machine. The cutter is planed or milled to the section of the tooth required, and is placed at such an angle in the tool-holder that it is sharpened by merely grinding on the end, the tool thus retaining its shape accurately until quite worn out. The feed is automatic, and varies in amount, gradually lessening as the cutter, entering farther into the work, has greater stress on it. For the last finishing stroke the feed ceases, so that a clean finish may be left on the teeth. The cutter is then instantly withdrawn, and the automatic dividing action being brought into play, passes to the next tooth, and so on. In this way hubs may be slotted quite automatically, and after being put on the machine, and the machine started, it requires no further attention till the last tooth is cut, when a bell rings to call attention. The bell may be set to ring at any other point if desired, or if required the machine can be made self-stopping. The machine can be made to run at varying speeds to suit various metals, but the reciprocating parts are made very light to suit the correct speeds for soft metals. The holder is so arranged that the cutter does not drag on the up-stroke. The countershaft is not shown in the engraving. The machine can be mounted on a bench or on a cast-iron pillar, as may be desired. In addition to its special purpose, the machine is also well adapted for a variety of purposes where light, rapid slotting is required. Mr. Charles Taylor, Barthelomew-street, Birmingham, is the maker of this useful tool.



TAYLOR'S PATENT SLOTTING MACHINE.

CULTIVATION OF INVENTIVE FACULTY.—We have received several solutions of Mr. Leicester Allen's problem given in our issue for April 28, and although no time limit was stipulated, we shall be glad if those who intend to submit solutions will send them in by the 20th inst.

ON the 3rd inst., Messrs. Short Brothers launched from their shipbuilding yard at Pallion, a steel screw steamer built to the order of Mr. James Knott, of the Prince Line of steamers, Newcastle-on-Tyne. The dimensions are:—Length, 295ft.; breadth, 37ft.; and depth 25ft. The engines are to be fitted by Messrs. Blair and Co. Limited, of Stockton, having cylinders 22ins., 36ins., by 59ins. diameter, and 39ins. stroke, with two large steel boilers, having a working pressure of 160lb. per square inch.

Metal-cutting Tools.

(Concluded from page 135.

Dies.—Dies are made of two distinct forms for both machine and hand use, the solid and the open. For bolt cutting the open or releasing die is almost universally used. While there are numerous different devices used by the several makers of these machines, they are similar in respect to their general characteristics. The die holder or head is fitted to the machine spindle, and carries usually four, sometimes but three, radial sliding bars, upon the inner ends of which the thread is cut. By means of a lever operating suitable mechanism the slides are thrown in or out, as it is desired to open or close the die. Both operations are usually made automatic, dependent upon the length of thread for which they are set. In closing, the slides are brought to an exactly central position by means of stops, and as soon as the desired length of cut has been reached they are thrown outward, entirely clear of the work, which enables it to be withdrawn without the necessity for backing out or even reversing or stopping the machine. Of course, this is a great time saver, and also prevents possible injury to the thread, which is liable to occur with the reversing method from chips becoming jammed in the teeth. The latter are given considerable angle of cut and clearance to enable them to work freely at the comparatively high speed of rotation desired. While this somewhat reduces their durability, it is of but little importance, as the teeth may be recut many times before the slides need to be replaced.

The solid dies used in bolt cutters are carried in a square socket in the head, which, while holding them against lateral motion, allows of perfectly free play in the plane of rotation, and which enables them to follow eccentricity of setting of the work. The qualities of the solid die, whether for machine or hand use, are substantially the same. For free cutting, the amount of thread surface should be reduced to the least possible limit consistent with durability. The clearance should be somewhat less than in the releasing die, as the work must be backed out. It is sufficient, however, to admit of very rapid and free cutting. The usual and simplest method of forming the cutting edges, and allowing the necessary space for chips, is to drill a large hole far enough back from the bottom of the thread to allow for proper depth of face, and from this hole the intervening metal is cut through, the face and heel of the teeth finished, and the clearance of the latter is then easily accomplished.

Most makes of solid dies, embodying late improvements, are made adjustable within a very limited range of variation—that is if it be desired to vary the size to cut tight or loose fits to standard taps, or to compensate for wear by means of several different devices, all of which are very simple and effective. For hand use the open die is used much less than formerly, as the solid form is fitted to the stocks and used in its stead. The necessary qualities are much the same as in the latter, and should enable the cutting of the full thread to be accomplished at a single operation instead of by the old-fashioned method of turning back and forth and making probably half-a-dozen passes. The dies should have the faces at the parting and centre opposite, the latter being of the form described for the solid die.

All dies, of whatever form or thread, if of large size, are best cut in the lathe, leaving only a light, scraping cut for finishing with the tap, in order to standardise and properly match the threads. Smaller sizes, of course, are made entirely by tapping. The hardening and tempering require to be much the same as for taps, though the manipulation is much less difficult, and the certainty of satisfactory result greater. Pipe taps and dies differ in some respects from the ordinary form, but may be considered as modifications of the general features alluded to. From the proportionately large diameters of the screw, as compared with pitches of threads, the grooving is much shallower in the taps, and the clearance spaces in the dies. For the larger sizes, both taps and dies for machine use are made releasing—the dies similar to the form described,—the taps collapsing into the body or stock by means of automatic devices of several different kinds. As these threads are cut in sizes up to about 15½in. diameter, the tools become decidedly ponderous by the time the limit is reached.

The Diamond-point Graver.—In skilful hands its adaptability is almost universal. All sorts and kinds of work, some of which to the layman would appear impossible, are within its scope. For work of moderate size, the graver should be made of square bar steel, of from ⅜in. to ½in. While not absolutely essential, it will pay to forge the point by upsetting it slightly and cutting off in a bottom swage. The form of face is that of a diamond, and is made by cutting back at an angle of about 45° from the corner of square. The temper should be full hardness, no drawing whatever being necessary. The length of body should not be too great, from 8in. to 10in. being ample. A shank or tang, like that of a file, should be drawn out on end, and an ordinary file handle of large size used. In using, the heel of the tool should be placed firmly on the rest, and as near to the work as will allow of its being used as a pivot. The edges may be used in any direction, according to the requirements of the work, though it is necessary in order to preserve the keenness of the edge, and also to ensure clean and rapid cutting, that the tool be held in such a manner as will give the effect of proper clearance such as would be given to a fixed tool.

Of course the graver, like any other tool for hand use, is limited in its capacity by the skill of the workman. As this is entirely a matter of practice and self-teaching, no elaborate rules can be laid down as to the proper manipulation. The various other tools used comprise square and round points of different widths—right and left-hand side cutting, and such special shapes of point as may be required, which are readily made on the grindstone and changed as often as necessary. Chasing tools for both male and female threads are much used in brass finishing, though but very little of late years on other kinds of work. They are readily made by hand by the use of a "hub" or spiral-grooved tap, run on the lathe centres, the tool to be cut being held on the rest and forced against the teeth of the hub, by which it is fed along until the end of the thread is reached, when it must be returned to the starting point and the operation repeated until the full thread is cut. The use of this tool for screw-cutting requires considerable skill to produce good work. It is particularly difficult to start the thread properly and avoid zig-zags, though after it is cut deep enough to be self-feeding there is no effort required. Brass finishing tools—except for such grades as phosphor-bronze and similar tough alloys—should always be made flat and comparatively thin, the angle of edge being either a right or slightly obtuse one; in fact, they are more of the nature of scraping than cutting tools. Scrapers for finishing cast-iron work after the rest tool should be made very thin and about 1in. to 1½in. broad. There should be a narrow piece of leather—new belting is good—placed between the scraper and rest, as without this cushion it will chatter badly, and smooth work is very difficult to accomplish.

Files.—Files being exclusively an article of manufacture, it is unnecessary to refer to them except as regards their selection and use. They are made with five different "cuts" or forms of teeth—the bastard, second-cut, smooth, dead-smooth, and float. The first four are cut both ways—*i.e.*, crossed,—while the float or saw file is cut but one. The former differ principally in the pitch or spacing of the cuts—the variation being in the order named, from coarse rapid-cutting teeth in the bastard, to very fine, almost imperceptible ones in the dead smooth. Of course there is an endless variety of shapes and sizes, to adapt them to the different kinds of work, all of which have a technical designation. In selecting files, the principal points which may be used as a criterion of quality are as follow:—Evenness of surface of teeth; straightness and freedom from twist or buckles; uniformity of cut, in the absence of isolated or grouped irregularities; perfection of teeth, as to their being undamaged during the processes of manufacture subsequent to cutting.

The durability of any particular file or make can only be ascertained by actual use, though, as a rule, one that continues to work freely and evenly after the teeth are reduced to normal working condition by the loss of the perishable points left by the chisel will usually prove satisfactory. If, however, there are a large number of entire teeth, as well as the point, missing, the file will be short-lived and generally unsatisfactory. Some makes of files, more than others, are liable to the destructive and aggravating "habit" of pinning—that is, the accumulation of bunches of metal which adhere so firmly to the teeth as to need considerable force to remove them. While all files are liable to give trouble from this cause if not properly used, with some no amount of skill or precaution will prevent its occurrence to such an extent as to make it necessary to discard the file to avoid spoiling the work. There are few things more trying to the patience of a good workman than to have a deep furrow ploughed in the surface he is carefully finishing, just as he may be putting on the last few strokes. With a good file this may be almost entirely prevented by thoroughly chalking the entire surface of the teeth, and repeating the operation as often as the latter begin to show through the white coating. This does not in the least impair the cutting of the file—on the contrary, it will work quite as freely and far more smoothly with than without the chalk.

Though one of the most used of all machinists' tools, it is safe to say that a good majority of alleged machinists do not know how to use it properly. The infallible test of good filing is to try a straight-edge across a filed surface of moderate width in the direction of the cut. If it be true, and not rounded over front and back, it will be an exception to the rule, and a proof that the workman was master of the tool. There are two radical faults to which this result is due—*i.e.*, the manner of holding the file, and the application of pressure and motion in making the double stroke. As to the former, the handle should be grasped firmly (not rigidly) in the right hand, the end bearing against the base of the large muscle of the thumb. The hand should be held with the back down, so that the thumb will be extended along the handle, and the fingers underneath, with the nails turned upward. This brings the hand and wrist in a direct straight line with the forearm, and enables the application of great muscular force with very little effort, while the only motion of the elbow joint is just what is necessary to maintain the parallel motion of the forearm against the vibratory motion of the arm from the shoulder.

For heavy filing, such as pushing a 14in. or 16in. bastard, the arm should be held well up to the side, and the weight of the body thrown on it, while the motion from the shoulder is replaced by that of the entire body for nearly the full stroke. The motion should be comparatively slow, but uniform and steady, and the return stroke be made with the pressure on file entirely removed. There are more file teeth broken out by failure to observe this than by the actual cutting. In draw filing, of course, the file cuts both ways, and therefore a uniform pressure may be maintained.

Hack Saws.—These tools might well be divided into two classes, those for brass and soft metals only, and those for iron, steel, and other equally hard material. By hardness, of course, is meant the dulling effect on the cutting tools, and as brass has a very small degree of such quality, the old style of saw made to be sharpened by filing is much the best. Being tapered from edge to back, the form of the blade obviates the necessity of setting the teeth. The form of the latter should be very shallow and the faces vertical, and filed square across. For the harder metals, the modern hard saw is a most efficient tool, and capable of work impossible to the softer saw. The proper method of using the tool of either type is to follow the manipulation described for filing, of course gauging the amount of pressure to suit the saw; slow, steady motion, and firm, uniform pressure on the cutting stroke, and quick motion and entire relief of pressure on the return. It is quite common to see good workmen using a hack saw much after the manner of a power jig saw, and they blame the saw when it becomes dulled or broken by such unreasonable usage.

The numerous ramifications of the subject of this article have led to its consuming much more time and space than was originally intended, notwithstanding the constant effort to be as brief as was consistent with its importance. While mention of many tools is necessarily omitted, the most important of those in general use are included in the numerous headings.—"Iron Age."

The Junior Engineering Society.

At the meeting of this society held on the 5th inst. at the Westminster Palace Hotel, Mr. Sidney Boulding, M.I. Mech. E., in the chair, the paper read was on "Gold Mining Machinery," by Mr. A. H. Bromly, manager of the Carndochan Mine, North Wales. The author first briefly considered the circumstances in connection with the occurrence of gold, and showed how the deposits were divisible generally into the classes (1) alluvial, (2) in veins or lodes. Its condition was in a comparatively pure metallic state, or else associated with some combination of baser minerals. The methods of working alluvial deposits by water and mercury and in other ways, and the treatment of veins or lodes by mining, were described. Reference was made to the tools used, including hand and power drills; to winding, hauling, and pumping arrangements; and to the various systems for the conveyance of the ore to the mill for reduction. In the reduction of "free milling" ores rock breakers were employed, the approximate results of a Blake-Marsden machine per hour being six tons of hard granite reduced to 2in. cubes; the machine was a 15 by 10ins. and ran 250 revolutions per minute. The Dodge crusher was also described. In illustration of the application of gravitation stamps, the author next gave an extended description, with his experiences of its erection in the Transvaal, of a 60in. stamp 900lb. mill. Particulars of the details, including the foundations, storage bin, grizzles, rock breakers, automatic feeders, mortar box, die, stem, tappet head, shoe guides, and cams, were given. The mill was driven by a turbine, and the estimated horse-power required was 176H.P., raising 2184 cubic feet of water per minute. The proper sequence of the fall of the stamps was a question of importance; it was arranged to keep the ore uniformly distributed in each mortar box, and to equalise the work upon the cam shaft. In the mortar box there were in five sections copper plates 3ft. long by 5ft. wide for the deposit of the gold amalgam. This was scraped off at intervals, retorted, melted, and cast into ingots, in which state the gold was known as bullion. The treatment of pyritic or refractory ores was next considered, and in connection therewith the Frue-Vannar machines and grinding pans were described, as were also the methods of concentration by buddles, and treatment of the concentrates by chlorination, smelting, and grinding. Of Krom's rolls and the Huntingdon centrifugal roller interesting accounts were given, and the results were recorded of some experiments on the former made by the author for presentation in the paper. Various systems of motive power for mining operations were reviewed, including steam, water, electricity, compressed air, petroleum, and the Pelton water-wheel; and the paper concluded with some observations referring to the general design, transit to destination, and arrangement of gold-mining machinery.

Shipbuilding Notes.

Messrs. Russell and Co., Greenock, have contracted to build a sailing ship of 1600 tons net for Messrs. Crawford and Rowat, Glasgow.

There was launched on the 1st inst., from Messrs. Sir W. G. Armstrong, Mitchell and Co's. Walker shipyard, a large steel screw steamer. The principal dimensions of the vessel are:—Length 357ft.; breadth, 43ft. 9ins.; depth, moulded, 28ft. 3ins.

Messrs. W. B. Thompson and Co. Limited, Dundee, have received an order for a steel screw steamer of about 1000 tons gross register for Messrs. Rankine, of Glasgow. The vessel will be fitted with engines of 1200H.P. She will be 240ft. in length, 32ft. beam, and 15ft. deep.

Messrs. Workman, Clark and Co. Limited, Belfast, launched, on the 3rd inst., a steel screw steamer of the following dimensions:—Length, 281ft. 3ins.; breadth, 39ft. 6ins; depth, moulded, 25ft. 4ins.; gross tonnage, about 2150. The builders have constructed triple-expansion engines with cylinders 22ins., 36ins., and 60ins. diameter, with a stroke of 42ins.

On the 2nd inst. there was launched from the shipbuilding yard of Messrs. S. P. Austin and Son, Wear Dockyard, Sunderland, a steel screw steamer of the following dimensions:—Length, 290ft.; breadth, 41ft.; depth, 21ft. 6ins.; gross tonnage, about 2400 tons. Triple-expansion engines will be supplied by Messrs. George Clark Limited, of Southwick Engine Works.

On the 1st inst. there was launched from the Cleveland Dockyard of Sir Raylton Dixon and Co., Middlesbrough, an iron steam trawler of the following dimensions:—Length, 100ft. 8ins.; beam, 20ft. 5ins.; depth, moulded, 11ft. 8ins. Triple-expansion engines will be fitted by the North-Eastern Marine Engineering Company Limited, of Sunderland, the cylinders being 11ins., 17ins. and 28ins. diameter by 21ins. stroke, with a large steam boiler working at 160lb. pressure.

There was launched on the 2nd inst., from the shipbuilding yard of Messrs. David J. Dunlop and Co., Port-Glasgow, the screw steamer "Delaware," built to the order of the Anglo-American Oil Company Limited, London, for carrying petroleum oil in bulk. The dimensions are:—Length, 345ft.; breadth, 44ft.; depth, moulded to spar deck, 31ft. 6ins.; gross tonnage, about 4000 tons. She is fitted with a set of triple-expansion engines, having cylinders 27ins., 43½ins., and 70ins. diameter by 51ins. stroke. There are two large double-ended boilers constructed for a working pressure of 160lb. per square inch. The oil-pumping machinery consists of two "Snow" duplex pumping engines, 14ins. by 14ins. by 12ins., placed in a pump room midships. These pumps are capable of a combined maximum output of 1000 tons per hour.

Some Applications of Electricity to Chemistry.

On the 29th ult., at the Royal Institution, Mr. James Swinburne, M.I.C.E., brought to a close his interesting course of Tyndall lectures on the above subject. In his second lecture he had just touched on a few points and difficulties connected with the manufacture of ozone, and this would be the first item in the third lecture. The formation of ozone might be illustrated in many ways, one of the most convenient being to pour a few drops of ether into a dry beaker, and allowing the ether vapour to mix with the air. If a solution of potassium iodide and starch were poured into the beaker and well shaken, a blue colour would be produced. Besides being a very powerful oxidiser it acted as a strong bleaching agent on vegetable colours, and was a useful material wherewith to attack germs. The beneficial qualities of ozone had been largely exaggerated, especially at the seaside; and the smell of the town drains had frequently been mistaken for the fumes of ozone. It had often a powerful effect on iodide of potassium, and this had been estimated by ozone test papers—*i.e.*, papers steeped in iodine of potassium. The lecturer then passed to another branch of his subject—the production of chemical change electrically at high temperatures. An experiment was made with a bottle of coal-gas in which a rod of carbon had been placed. When the electric current was applied the gas decomposed and the carbon came down in the form of smoke. The carbon on being taken out of the bottle was found to have decomposed a great deal of the gas, a rough deposit having formed over it. With a high temperature, carbon would come down in a light-grey colour. Another experiment was shown as to the amount of current that an incandescent lamp would stand. Mr. Swinburne said the Westinghouse Company had provided him with two "wasters"—*i.e.*, lamps not fit for ordinary purposes,—and he proposed to try to break these with the current at his disposal. A current of 99 volts on the one lamp and 100 volts on the other were, however, insufficient to cause the lamps to break, though it succeeded in blackening the glass to a considerable extent. The electrical furnace was generally supposed to be a recent invention, but Sir Humphry Davy was one of the earliest, if not the earliest, to use it. Another early experimenter made use of the electrical furnace for the manufacture of incandescent lamps with iridium. One of the best furnaces was that invented by Messrs. E. H. and A. H. Cowles, of Cleveland, Ohio, U.S.A., who accomplished by its help the reduction of refractory oxides at high temperatures. The construction of the Cowles furnace was explained. Another furnace was shown, consisting of a copper ball with small crucible, in which a small piece of platinum was placed with an arc light on each side of it. When the current was applied the platinum was rapidly fused. An attempt was made to cause tungsten to fuse. Though a tremendously high temperature was obtained, so that the copper ball became quite red hot, the experiment did not perfectly succeed, though the lecturer remarked that it had fused as much as it was ever likely to do. He had devised a method by means of which the audience would be able to see what was actually going on in the furnace. This was accomplished by the aid of a mirror, which threw a reflection on to the screen. A reference was made to the experiments of Professor Moissan, who claimed to be able to make diamonds electrically, though unfortunately only black ones. The reduction of compounds of phosphorus, silicon, and aluminium was also shown.

Notices of New Books.

The Steam Engine: A Treatise on Steam Engines and Boilers. By Daniel Kinnear Clark, M.Inst.C.E., M.I.M.E., etc. London: Blackie and Son. 2 Vols. (50s.)

This is a most ambitious attempt to provide at once a comprehensive and practical treatise on the steam engine in all its aspects. The difficulties in the way of accomplishing such a task satisfactorily are immense, and great credit is due to the author for the successful production of the two handsome volumes before us. Mr. Clark is already well known as the author of several important works, the most noteworthy being his treatise on "Railway Machinery," and his elaborate "Manual of Rules, Tables and Data for Mechanical Engineers." His latest effort will worthily sustain his well-earned reputation as a writer on engineering subjects.

It is impossible in the space at our disposal to adequately summarise the contents of these two elaborate volumes, or to notice all the points worthy of mention; and we must refer such of our readers as desire to become acquainted with the latest developments of the steam engine to the work itself. The labour involved in its compilation must have been enormous, and enough to daunt the courage of most men. The various subjects are well selected and arranged, and the treatment throughout is clear and thorough, and fully realises the author's intention "to provide a comprehensive, accurate, and clearly-written text-book, fully abreast of all the recent developments in the principles and practice of the steam engine." During recent years great advances have been made in steam-engine practice, rendering some well-known works on the steam engine antiquated and of little value to practical engineers, except from a historical point of view. This work, in view of these advances, has been written with the object of expounding the underlying principles and describing the present practice as "exemplified in the construction and use of modern steam boilers in all their varieties of form—stationary, portable, locomotive, and marine. To accomplish this, the author has availed himself of the numerous published records of investigation and practice—British, American and Continental,—and has added thereto the results of his own investigations, based on direct experimental inquiry carried on during many years." The work is divided into four main sections—viz.: I. The Principles and Performance of Steam Boilers. II. The Principles and Performance of Steam Engines. III. The Construction of Steam Boilers. IV. The Construction of Steam Engines.

The first portion of the first volume deals with the properties of steam, combustion of fuels—comprising the principles of combustion,—the emission of heat, temperature of the fire in furnaces of steam boilers, and distribution of the furnace heat absorbed by steam boilers. A large portion of this section is devoted to an exhaustive account of numerous systematic trials of coal as fuel, a very full description of various contrivances for prevention of smoke from furnaces of steam boilers, and to systematic trials of furnaces and boilers of all the leading types. So complete is this part that it would be difficult to suggest in what way it could be improved or supplemented. The disposal of the heat of combustion, products of combustion, evaporative performances of multitubular flue boilers of the locomotive type, relations of grate area, heating surface, etc., are all in turn fully discussed. The description and illustration of mechanical stokers is very complete, and forms a very interesting history of the development of this important adjunct of the steam boiler.

Gas furnaces and powdered-fuel furnaces also receive notice. The chapter on factory chimneys is very concise and clearly written, and the practical rules formulated by the author, based on the experiments of Carmichael and others, appear to give results agreeing very fairly with those obtained in practice. The table of relative working dimensions of factory chimneys, total grate area and consumption of coal, given at the end of this chapter, will be found particularly useful by anyone desirous of reliable data on this subject.

The concluding part of the first portion of this volume discusses the work of steam in single and compound engines (the formulæ for which are worked out in a simple manner by the aid of the simplest of mathematics), behaviour of steam in the cylinder in all its phases, the practice of expansive working in steam engines, testing of steam engines by thermal analysis, and frictional resistance of steam engines. The last section in this volume is devoted to the construction of the steam boiler, and treats of the elemental strength of steam boilers, and tests of strength of steam boilers, giving description and illustration of nearly every type of boiler in use.

The first portion of Vol. II. is devoted to the construction of the steam engine, the first part being concerned with a very exhaustive discussion of the slide valve and link motions, description of Hackworth and other valve gears, automatic expansion Corliss and other "slip" gears, as the author terms them.

And here we may remark that the author throughout exhibits a few—shall we call them "mannerisms"?—such as "indicator" horse-power, "formulas," "slip motions," etc. The chapter on governors is not so complete or practical as it might have been, and we are surprised to find no reference to the formation of the fly-wheel or any rules of a practical nature relating thereto. This is a subject that Mr. Clark might have handled with success, and it is one of considerable importance to the practical engineer.

Indeed, one of the most obvious defects in this work on the steam engine is the entire absence of constructional rules of a practical kind for the various details of the steam engine. It is only reasonable to expect that in a work of this character a few rules of general application would have been given for guidance in the designing of engine details, and this want will detract to some extent from the value of the work from a practical point of view. The examples of stationary steam engines of all kinds are well selected and very numerous, embracing nearly all the types worth illustrating.

Corliss engines of various types are well illustrated, and the examples given comprise a very complete collection of the various trip gears by English makers, although there are a few very good gears in the market which have not been included; also Mr. Clark seems to have ignored Continental and American practice in the matter of trip gears. Large mill engines for driving cotton mills come in for ample illustration, the particulars given being very full, even to the weights of the separate parts and the selling prices of the engines, which is a valuable feature of the book. Pumping engines of various designs by the leading makers are fully illustrated, and special steam engines, such as rolling-mill, winding, and blowing engines, are not omitted, although these are not very numerous. Two types of overhead wall engines are illustrated, such engines being used in several places for driving locomotive machine shops. Portable engines also receive fair notice, and a number of tests of these engines are added.

Multiple-compound or multiple-expansion stationary steam engines are considered in the next chapter, and a number of examples of this type of engine illustrated. The latter portion of Vol. II. is devoted to railway locomotives and marine engines, the latest examples of the respective types being well described and illustrated. The illustrations are exceedingly well executed, and are to scale.

An addendum follows, dealing with miscellaneous matters, such as calculation of horse-power of steam engines, table of laps, etc., of slide valves, special types of boilers, compensating pumping-engines, and air-compressing engines. The work is enhanced by a very copious index, which greatly facilitates the finding of any subject the reader may wish to consult. The work is a monument of patient and careful labour, and will be found an invaluable reference book for engineers and steam users.

Logarithmic Tables. By G. W. Jones. London: Macmillan and Co. Ithaca, N.Y.: Geo. W. Jones. (4s. 6d.)

This is the fourth edition of a capital set of logarithmic tables which have been prepared by Prof. Jones, of Cornell University, Ithaca, N.Y. There are tables given of four-place logarithms and of trigonometrical functions; a six-place table of logarithms of four-figure numbers, with a table of differences; addition and subtraction logarithms; sines and tangents of small angles; trigonometric functions; natural logarithms; prime and composite numbers; squares, cubes, roots and reciprocals; quarter squares, Bessels coefficients, binomial coefficients, etc. The tables are admirably arranged, while the type is varied in size to facilitate reading, thus avoiding straining the eyes and saving time. The type is clear and the work throughout has been executed in a highly creditable style. It is the most conveniently arranged set of tables that we have yet met with, and as the book is published at a very moderate price, it will doubtless be largely used.

We have also received Cassell's new "Technical Educator," the first volume of which contains articles on technical education, drawing for carpenters and joiners, cotton spinning, cutting tools, carpentry and joinery, dyeing of textile fabrics, electrical engineering, drawing for engineers, photography, plumbing, practical mechanics, projection, the steam engine, steel and iron, watch and clock making, and woollen and worsted spinning. Generally speaking, the subjects are well handled, although the papers on the steam engine appear to us unnecessarily involved, while the treatment is not sufficiently practical for the purpose in view. To those who seek advancement by self-education, the "Technical Educator" may be confidently recommended.—Of the new edition of Vere Foster's drawing books (Messrs. Blackie and Son Limited), Part 17 deals with scale drawing and practical architectural drawing; Part 18 with shaded ornament. The examples in each are carefully graduated and well selected.—From the Walker Manufacturing Company, Cleveland, Ohio, we have received Part I. of the 10th edition of the gear catalogue of this well-known firm. In addition to the list of gears—which is a very complete one—there is also given a large amount of useful information on power transmission generally. A paper explanatory of Walker's system of gearing is appended, with some useful rules and tables on power transmission by belts, ropes, etc. We note, however, a statement to the effect that "the largest number of ropes employed on one pulley is probably 38." This may be correct so far as American practice is concerned, but in this country several wheels grooved for 54 1⅝in. ropes have been made, and at least one for 67 ropes, which transmits 4000I.H.P. We have also to acknowledge the receipt from this firm of a large photograph showing the interior of the shops.—The "Technical World" is a new weekly journal of technical and secondary education. The first number (2d.) contains several readable papers on educational subjects, views of technical schools, etc.

Trade Notes.

Messrs. F. Wiggins and Sons, London have obtained the Admiralty contract for the supply of mica.

Messrs. George Russell and Co., Glasgow, are erecting three cranes at the Mavisbank Quay, in that city.

Messrs. A. and J. Main and Co., Glasgow, have obtained a large order for malleable-iron railings for the Springburn Park, near that city.

Messrs. Tannett, Walker and Co. Leeds, are making a quantity of hydraulic plant for the Gas Light and Coke Company of London.

Messrs. Sir William Arrol and Co., Glasgow, have secured an order for the construction of a bridge measuring 190ft. by 15ft. over the Girvan.

Messrs. Cowans, Sheldon and Co. Limited, of Carlisle, have just completed and erected a large steam crane for the Clyde Trust. The total cost, including foundations, is £16,000.

Messrs. Manlove, Alliott and Co. Limited, of Nottingham, have obtained the order for the mixing and pressing machinery for the Weybridge and Oatlands sewage scheme.

The Ynisced wyn Tinplate Works, situate in the Swansea Valley, were offered for sale by auction at Swansea on the 2nd inst. Mr. Owen, late of the Midland Works, purchased them for the sum of £3000.

The directors of the Sharpness New Docks have contracted with Messrs. Sir W. G. Armstrong, Mitchell and Co. Limited, of Newcastle-on-Tyne, to supply the hydraulic machinery for working the dock gates, etc.

Messrs. W. T. Henley's Telegraph Works Company Limited have just laid a telephone cable across the Tay, near Dundee, for the National Telephone Company. It consists of 14 wires insulated with gutta-percha, and is 1¼ mile long.

Messrs. John Abbot and Co., Park Works, Gateshead, have just built and delivered to the order of the London and South-Western Railway Company, for the Southampton Docks, three large boilers of the Lancashire type, each having a length of 30ft., a diameter of 7ft. 6ins., and flues 3ft. in diameter.

A twelve months' contract for the whole of the Admiralty requirements in steel rigging ropes and galvanised flexible steel hawsers has just been placed with Messrs. R. S. Newall and Son Limited, of Glasgow, who have also secured a three years' contract with the same Department for the supply of flexible iron wire ropes for Her Majesty's dockyards.

Messrs. Spurr, Inman and Co. Limited, Wakefield, have received an order from the Great Northern Railway Company for five Lancashire high-pressure boilers, with stoker, economiser, etc., for their Holloway electric-lighting station. This firm is also making a number of Lancashire boilers for Messrs. Gunning and Campbell Limited, of Belfast

Recent Boiler Explosions.

(*Continued from page 52.*)

No. 583 refers to the explosion of an externally-fired boiler at a colliery. A rent occurred in the bottom over the fire, opening out 19in. × 3in., thus allowing a free escape of the contents. It is said to have been due to shortness of water; but from the evidence, which was of a very conflicting character, it is most likely that the plates suffered from time to time from the presence of deposit, and the present fracture was simply the climax of a growing defect. Several of the plates were out of shape, and the fracture did not cause any report, but simply a "big" leakage, no personal injury or damage being done. This class of boiler has no recommendation beyond its low first cost, and it is fast dying out.

No. 584 refers to the fracturing or pulling asunder of a defective arrangement of copper pipes of a marine boiler. Arrangements were made for the pipes to slide in a stuffing box. This appears to have been neglected until it set fast, and when the ship was rolling at sea, and the boilers also likely to move, the pipe formed a rigid tie, and was pulled asunder. Fortunately no one was injured.

No. 585 refers to the explosion of the uptake of a vertical boiler on a fishing boat. The owner thought himself quite capable to manage his own boiler, but the Commissioners thought differently, and as one error made known often reveals another, they were able to find out that the owner was in the habit of tampering with the safety valve, and as he had the lives of his crew in his hands they fined him £15 for not having had the boiler examined and for having wilfully tampered with the safety valve.

Report No. 586 refers to a so-called explosion on a fishing boat, and consisted of a small perforation of the smoketube or uptake. The boiler was a vertical one, and the uptake passed through the steam space, and was subject to corrosion. In this case one pitting extended through the plate, causing a slight leakage, which has been designated an explosion.

Report 587 is a similar case to the above, and the two might fairly have been described in one report, and by one sketch. Again, by a stretch of the imagination we get No. 588 described as an explosion, while really it is simply a leakage from a slack stay.

No. 589 was, however, something of a more serious character, a piece being blown out of the side of a stop-valve casing. The only peculiarity about this inquiry is that the explosion took place in April, and the inquiry in October.

No. 590 refers to an investigation of the explosion of a cast-iron kier or "cloth-boiling pot," known to have been in use continuously since previously to 1851. As time went on less care seems to have been used, and the Commission considered that sufficient precaution was not taken to prevent over-pressure, and fined the manager £40. The safety valve was removed, the reducing valve was unreliable, and the pressure gauge was practically useless, so that the occurrence of an explosion was not a matter for surprise. One life was lost.

No. 591 refers to the explosion of a small cylindrical boiler fired externally, and due to internal corrosion. The boiler was purchased second hand, the maker and its age being unknown. Great neglect seems to have been exercised in this case.

No. 592 refers to a case in which the bottom of the combustion chamber appears to have been in a defective condition, and had been previously patched, further corrosion developing itself since the said patch was applied. No doubt the patch would be leaky, and the corrosion result therefrom. It is said in the report that this defect could have been detected by sounding. It ought, however, to have been seen, being in the bottom of the combustion chamber. If it could not be seen, it is not likely sounding would be of any use when there were so many patches and seams in the immediate neighbourhood. The stoker appears to have stood manfully to his duty, being nearly ankle deep in scalding water while he drew the fires, and getting severely scalded in doing so.

No. 593 is a report on the bursting, or rather collapsing, of a metal tube in a tramway engine. These are often taking place, and occasionally are of a serious nature. We are, however, of opinion that they need neither be frequent nor serious if good solid-drawn steel tubes are used instead of some of the patent metals now on the market. It is quite a mistake to sacrifice safety for the sake of economy. These patent tubes may be of slightly higher conductive power, but they often show themselves unreliable. In this particular case the tubes had only been in eighteen months, and were said to be exceptionally thin; still they were allowed to work on.

Report No. 594 refers to the breaking of a cast-iron steam pipe connecting a steam hammer with a small boiler. The pipe was of considerable length, and water would be likely to accumulate in it, so that a careless opening of the valve would be sufficient to cause a water-hammer action to be set up, and so fracture the pipe. Drain pipes properly attended to would have saved this.

No. 595 refers to the burning out of the bottom of a Field tube in the boiler of a tramway engine. These tubes are very efficient when in use; but when sedimentary water is used, and dirt settles in the bottom, they burn through before the circulation can clean them. This seems to have been the case in the present instance.

(*To be continued.*)

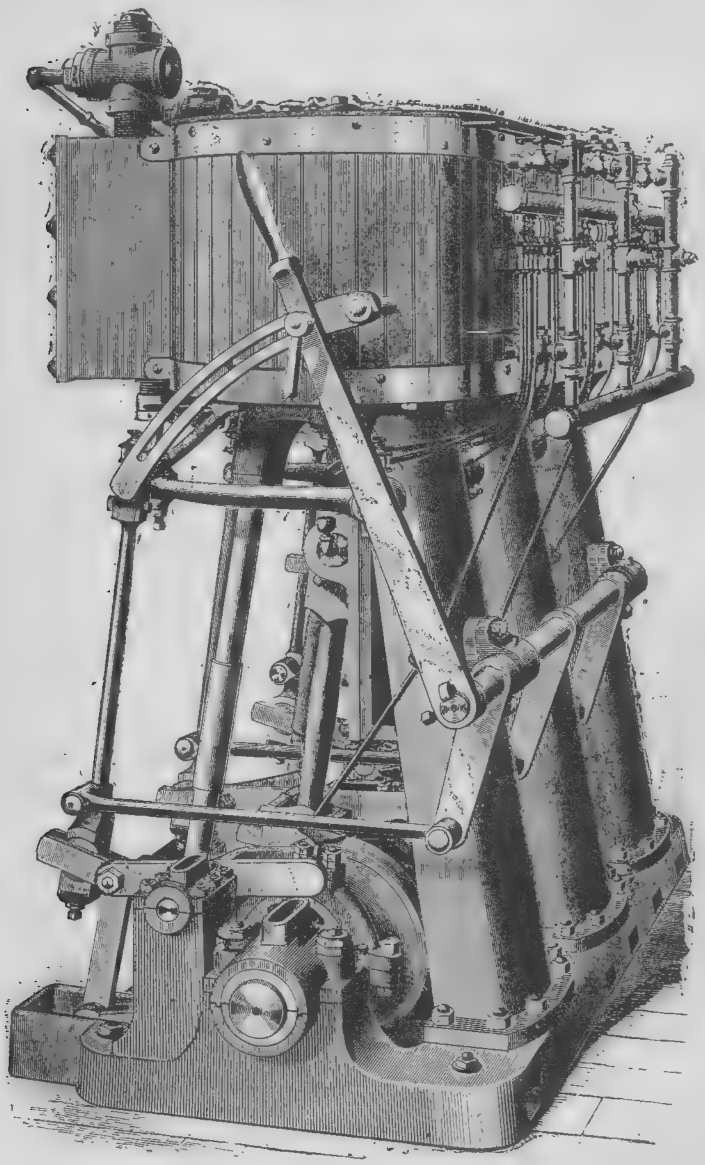


Fig. 1.

TRIPLE-EXPANSION YACHT ENGINES.

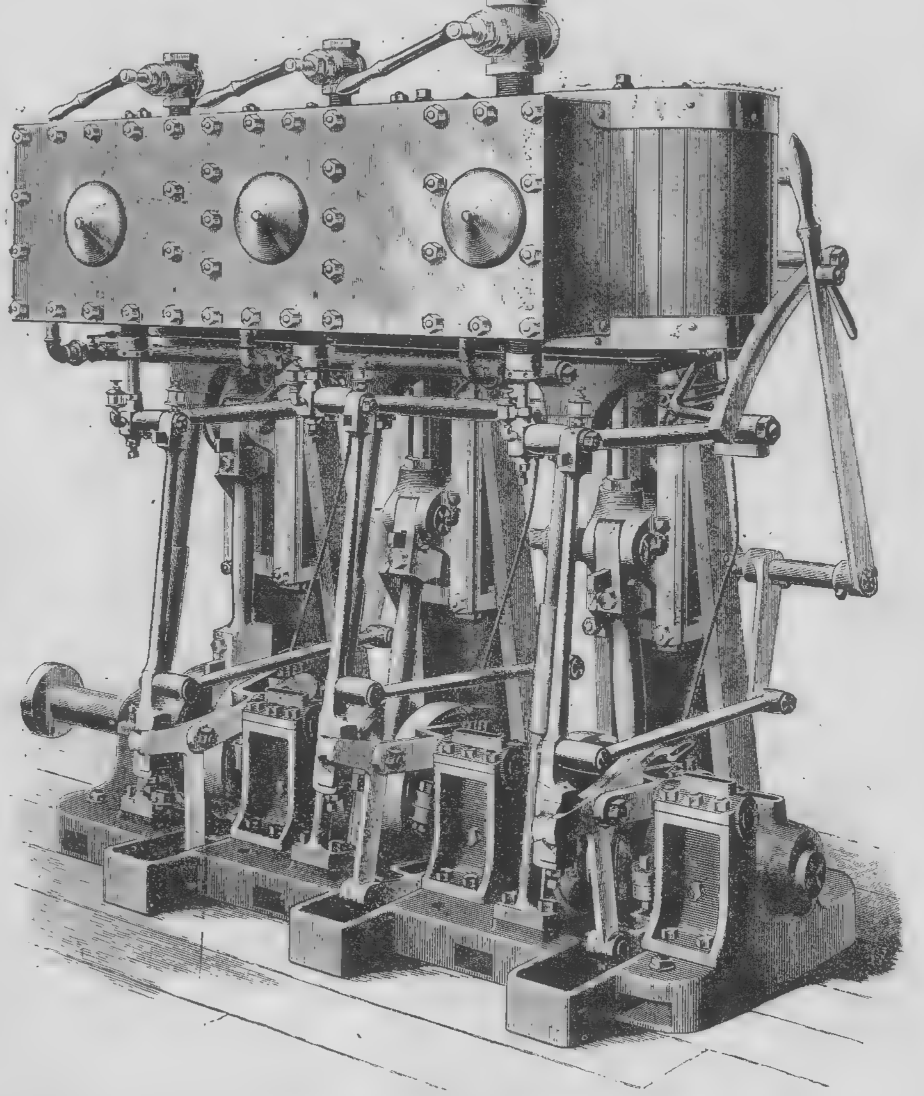


Fig. 2.

Triple-expansion Yacht Engines.

WE give herewith illustrations of a set of triple-expansion yacht engines of American design, the valve gear of which has some decidedly novel features. The cylinders are 7, $10\frac{3}{4}$, and $16\frac{1}{2}$ins. in diameter, the stroke being 8ins. The high and medium-pressure cylinders are provided with piston valves, which are bolted to false seats to facilitate removal for repairs when necessary. The low-pressure cylinder has a double-ported slide valve. The valve gear is of the radial type, and has been designed by Mr. L. D. Davis, of the Davis-Farrar Company, Erie, Pa., the builders of these engines. The cylinders, as will be seen from Figs. 1 and 2, are supported at the rear by hollow cast columns, and at the front by polished wrought-steel columns, making the working parts very accessible and open for inspection. The crosshead is of polished cast steel, carrying a slipper guide at the back, operating in slides formed by the face of the cast column, and with wrought guides to take the thrust when backing. The guides, as well as all the working parts, are adjustable for wear. The crosshead pin is a taper fit with a substantial dowel on one end and a split taper bush on the other, secured and joined with a screw, a cap fitting snugly between the screw head and face of the crosshead, completely covering the joint and giving a finished appearance to the whole. The pin is hollow and is oiled from the centre. The connecting rods are of the strap-and-key type, requiring less care in taking up wear than the forked type. The crankshaft has the coupling forged solid with it to economise weight.

The valve gear shown in Figs. 3 and 4 is extremely simple. Although but one valve is used, it gives a steam distribution similar to the "Corliss valve motion," the fast travel of the valve being when the port is opening and closing for steam, the slow travel when the port is fully open and during exhaust. Its construction and action will be understood from Figs. 3 and 4, of which Fig. 3 shows the gear in skeleton. It consists of an ordinary eccentric and eccentric strap, with a pin upon its top and bottom sides; and a link connected to the pin on the top of the eccentric strap, extending horizontally 12ins., and pivoted at a point 9ins. from the centre of the pin at the top of the eccentric strap. This fixed point is supported by a stand bolted to the engine base. At the outer end of this link a T-shaped quadrant is carried, the lower arm of which extends downward, and is connected with the bottom of the eccentric strap by the lower horizontal link. It will be seen that the vertical throw of the eccentric operating the upper link or lever over its fixed point or fulcrum carries its outer end with the quadrant a distance equal to the lap and lead of the valve, while the horizontal throw of the eccentric imparts a "rocking motion" to the quadrant. It is, therefore, obvious that as the eccentric rod is moved from the centre toward either end the port is opened more for steam or the engine reversed, and that there can be no port opening for admission other than the lead when the eccentric rod is in the centre of the quadrant. It will be seen that the eccentric is practically a crank, and has both vertical and horizontal throw, consequently there are fast and slow points of travel. The vertical throw of the eccentric is used to move the valve a distance equal to the lap and lead—nothing more,—and the horizontal throw is used for port opening. Each has its fast and slow travel. So far as moving the valve is concerned, the relation is the same as that of the piston of an engine and its crank.

In the middle sketch it will be seen that the engine is on the bottom centre. The throw of the eccentric, being down, has raised the valve K a distance equal to the lap and lead, and it is ready to take steam. At the same time the full horizontal throw, its fast travel, is ready to move the lower arm G of the quadrant to the right and rock its outer end with the eccentric rod up, giving the port opening with its quickest travel. The next cut shows the port open.

It will be seen that the beginning of the vertical throw would tend to close the port, while the horizontal throw, rocking the quadrant more, maintains the valve in its position. The one operating against the other causes the valve to pause or slow up.

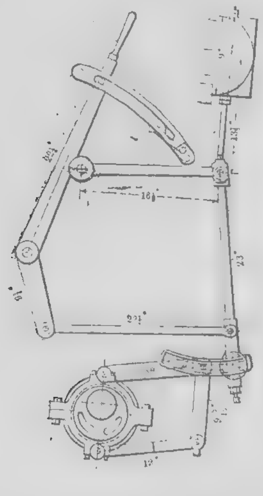
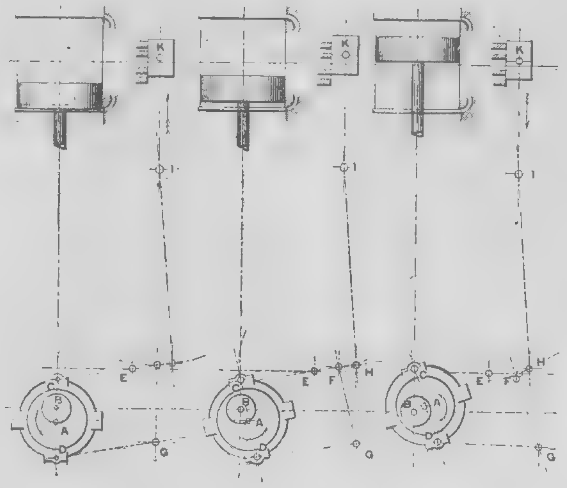


Fig. 3.



Triple-expansion Yacht Engines.—Fig. 4.

In the last figure it will be seen that the vertical throw is at its fastest point, while the horizontal movement is at its slowest, and will have little effect to oppose it.

Two years' use of this valve gear has developed no faults or weakness, while the steam distribution, according to the "Iron Age"—to whom we are indebted for most of these particulars,—is all that could be desired, giving a quick opening and closing, maintaining a full port opening for admission and free exhaust, while there is no perceptible difference in the events of induction, release and compression on either stroke, from maximum point of cut-off to zero.

The "Excel" Pneumatic-power Hammer.

Although the pneumatic-power hammer appears to possess several distinct advantages over the steam hammer for certain classes of work, it cannot be said that the tool has hitherto met with much favour. Difficulties connected with the operation of the valves have in many instances proved a serious objection, and no doubt this has in a very great measure militated against the use of this type of hammer.

We have pleasure in directing attention to a new form of pneumatic hammer now being introduced by Messrs. Greenwood and Batley Limited, Albion Works, Leeds, two examples of which are shown in the accompanying illustrations, Fig. 1 being a single upright, and Fig. 2 a double upright hammer. A special arrangement for operating the valve is employed, consisting of a wedge-shaped shoe which slides in a recess in the frame, and to which a vertical movement is imparted by means of the regulating lever. In this way the opening of the valve, and consequently the weight of the blow, can be regulated to the greatest nicety.

A great feature in this hammer is the fact that when the tup is making from 150 to 400 blows per minute, according to the size of the hammer, it can be stopped *instantly*, without interfering with the belt-driving arrangement, the faces of the dies remaining from 4ins. apart in the smaller machines, to 15ins. in the larger sizes. This, the makers claim, is not accomplished by any other power hammer in the market. A further advantage is that when the machine is working at full speed, the operator can strike the heaviest or lightest blows alternately, or at will. The blow can be regulated either by hand or foot levers, and the tup can be made to strike heavy or light blows, and be stopped or started instantly without interfering in any way with the driving belt.

The makers claim that a much heavier blow can be struck by this machine without fear of damaging the hammer, than by a steam hammer of similar size, and this at about one-twentieth the cost in driving power. These hammers, which are made in various sizes, from ½cwt. to 20cwt., are already used for cutlery work of all kinds, file forging, edge tools (light and heavy), pick drawing, fork drawing, spade and shovel plating, carriage and cart-axle forging, as well as for general forging purposes, tilting steel, etc. We may say that we recently paid a visit to the interesting works of Messrs. Greenwood and Batley Limited, where we saw one of these hammers in operation, and several in course of construction. We may add that this firm have an electric car of novel construction, running on the ordinary railway lines in the yards of these extensive works. The current, which is supplied at 150 volts, is collected from an overhead conductor by a trolley, in the usual manner. Two motors are employed, each of which drives on to one of the car axles by means of worm gearing. Particular care has been taken to secure as high a degree of mechanical efficiency as possible in this connection. A three-threaded steel worm is employed, gearing with a bronze worm wheel, the worm running in an oil bath in order to ensure continuous and efficient lubrication. The regulation of the speed of the car is effected by variously combining the winding, four speeds being obtained in this way. The car is under the absolute control of the driver, and it certainly works in an eminently satisfactory manner.

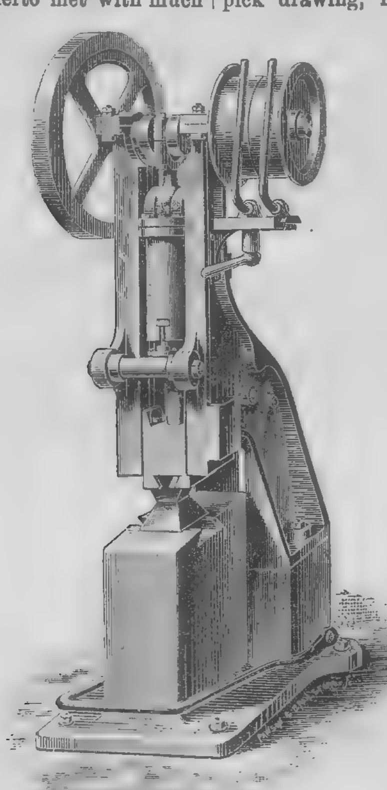
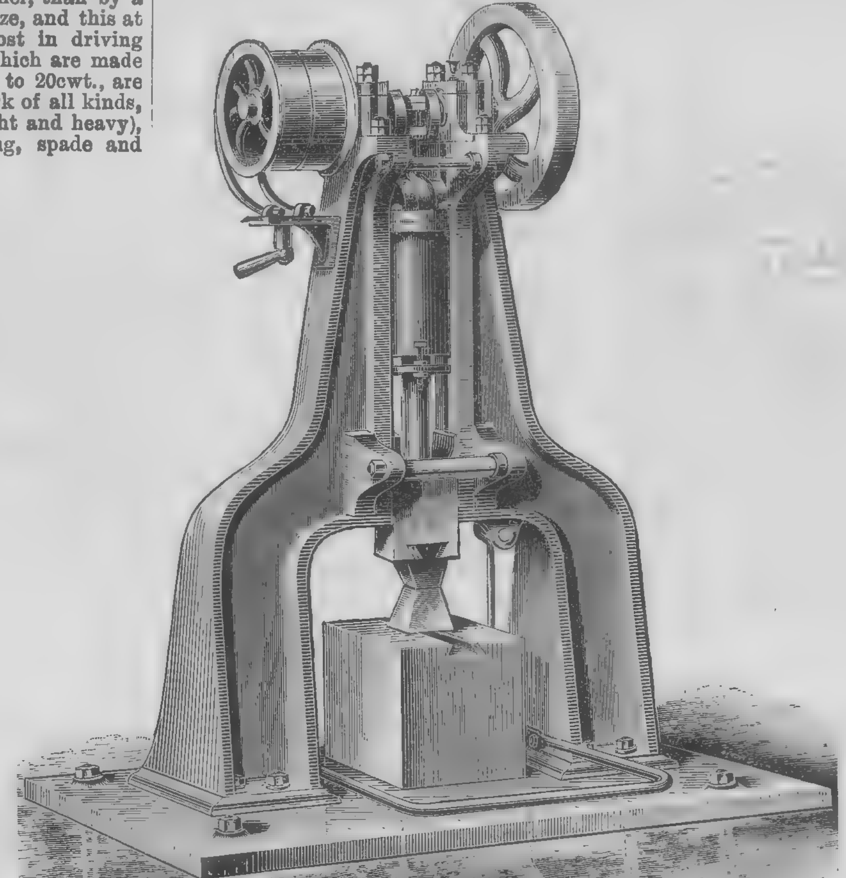


Fig. 1.



The "Excel" Pneumatic-power Hammer. Fig. 2.

Practical Hints to Boilermakers and Templaters.—I.

By a Foreman Boilermaker.

That the principles of the art of boilermaking do not receive the necessary attention from the majority of practical boilermakers is a fact only too patent to all those who are engaged in the trade, and one of the greatest difficulties experienced by a foreman is the struggle against the prevailing want of a knowledge on the part of his men of rudimentary geometry and templating in its simplest forms. This necessitates his whole time and attention being given to the initial stages of setting-out plates, and doing that work which every boilermaker's plater should be able to do for himself from an intelligible working drawing, thus leaving the foreman to superintend his men; to keep his shop in fair, square, and proper order; to see that the machines are kept clean and the passages clear; as well as to see that his men are all satisfied, and that his employer gets full value in work for the money paid in wages. But it sometimes happens that the foreman himself does not possess the information that he should be master of, hence the many inaccuracies that occur in the manufacturing of boilers, and which render inspection so very necessary.

Every boilermaker should thoroughly understand the importance of his work, the risk to life, limb, and property that depends very much on his skill and care as a craftsman. To understand his work he requires to have a fair education, a sound knowledge of the first principles of geometry, and above all a strict application of his knowledge to his work.

Every boilermaker knows the advantages of having his plates cut to proper size and shape before being rolled up or bent into shape, and he is equally aware of the disadvantages due to their not having been properly set out; of having to cut and carve in awkward positions—perhaps to flange over double the amount of material to what is required; and when the job is finished—from incessant fire work and hard abuse, even though finally annealed—it is more fit for the scrap heap than to form a part of a steam boiler. Frequently subsequent fracture and failure can be easily traced to the boilermaker, but its origin is in bad setting out at the beginning. Too much care cannot be bestowed on the setting-out of boiler plates, and it is to these several points that the writer would earnestly draw the attention of every intelligent boilermaker, and especially of those apprentices whose ambition is beyond the big block hammer or the red-hot rivet. Mathematical terms or intricate searchings will be altogether avoided, the endeavour being to describe and illustrate in the simplest manner possible every-day practice in the modern boiler-shop.

To the apprentice and journeyman alike the writer would urge the necessity of being thoroughly grounded in the principles of geometry, for therein lies the whole secret of a successful setter-out. From drawings supplied, and with the aid of a piece of chalk, a two-foot rule, and a pair of compasses, he should be able to set out and develop his work on purely scientific methods. When such is the case, it is a pleasure to himself, to his foreman, and to the workers who follow him, and a credit to his employers, because everything goes smoothly; the men are not overworked; and where due caution is employed a satisfactory job is turned out profitable to the employers and a credit to the men.

The marine boiler and its connections give the greatest scope to the geometrician, and the problems involved therein—which will be submitted in a subsequent paper—are problems of every-day practice, and such as have come under the personal observation of the writer. They will be found useful to those in search of information of this kind, and some of them—so far as the writer is aware—have not appeared in any of the text-books or mechanical

journals. The Lancashire boiler is a simple structure; but the keen competition amongst makers renders the utmost care and watchfulness all the more necessary to bring it out successfully. The boiler most in favour just now has the "Adamson" flue, which consists of a series of rings welded in their entire length, flanged on both ends, and held together with steel flat rings called caulking rings, 2½in. by ½in. The whole when riveted together makes a very rigid and much-approved joint. The Galloway tubes are mostly eight or ten in number, and are now made of mild steel. They are sometimes welded in, a process not always to be commended. The shell is made up of so many belts of one plate to each belt, on the system of what is universally called "square plating"—*i.e.*, an outside belt and an inside belt alternately. This necessitates the making of two templates, one for the outside belt and one for the inside belt. Telescope plating is now almost a thing of the past, even on egg-ended and boilers fired externally.

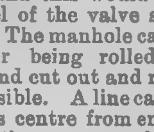
The writer gives below a list of materials required in the construction of a Lancashire boiler of the Adamson type, 28ft. long by 7ft. 6in. diameter, for a working pressure of 80lb. to the square inch. The boiler when finished should weigh about twelve tons, and would cost about £80 for labour.

ONE LANCASHIRE BOILER, 28FT. × 7FT. 6IN.

Test pressure, 160lb. to square inch; working pressure, 80lb. per square inch; all rivet holes drilled; all rivets $\frac{13}{16}$in. diameter finished; circumferential joints single riveted; longitudinal joints double riveted.

LIST OF MATERIALS.

4 mild steel plates, 24ft. 1in. × 50½in. × ½in., for outer shell.
3 mild steel plates, 23ft. 9¾in. × 50½in. × ½in., for inner shell.
1 mild steel plate, 8ft. 1in. diameter × ⅝in., for back end.
1 steel angle, 25ft. 4in. × 3½in. × 3½in. × ½in., for front end.
28 steel angles, 1ft. 6in. × 3½in. × 3½in. × ½in., for gusset bars to shell.
4 steel angles, 2ft. 6in × 3½in. × 3½in. × ½in., for gusset bars to ends.
4 steel angles, 2ft. 3in. × 3½in. × 3½in. × ½in., for gusset bars to ends.
4 steel angles, 2ft. × 3½in. × 3½in. × ½in., for gusset bars to ends.
4 steel angles, 1ft. 6in. × 3½in. × 3½in. × ½in., for gusset bars to ends.
8 steel angles, 1ft. 3in. × 3½in. × 3½in. × ½in., for gusset bars to ends.
2 steel angles, 12in. × 3½in. × 3½in. × ½in., for gusset bars to ends.
2 steel angles, 9in. × 3½in. × 3½in. × ½in., for gusset bars to ends.
2 steel plates, 6ft. 6in. × 16in. × ½in., for gusset stay top centres.
4 steel plates, 6ft. 6in. × 13in. × ½in., for gusset stay mid-centres.
4 steel plates, 4ft. × 13in. × ½in., for gusset stay sides.
2 steel plates, 3ft. 6in. × 11in. × ½in., for back bottom.
2 steel plates, 3ft. 6in. × 9in. × ½in., for front bottom.
13 mild steel plates, 9ft. 5in. × 42⅞in. × $\frac{7}{16}$in., for flues.
1 mild steel plate, 9ft. 5in. × 33¾in. × $\frac{7}{16}$in., for flues.
1 mild steel plate, 7ft. 10in. × 33¾in. × $\frac{7}{16}$in., for flues.
1 mild steel plate, 7ft. 10in. × 42⅞in. × $\frac{7}{16}$in., for flues.

2 plates to sketch  for flues.
8 plates to sketch for pipes.

4 steel angle bars, 10ft. 6in. × 3½in. × 3½in. × ½in., for ends of flues.
16 steel flat bars, 10ft. 2in. × 2½in. × ½in., for caulking rings.
1 safety-feed steam and blow-off stool.

The last item should be made of mild cast steel, the rivet holes cored ½in. less than finished size, to be drilled out afterwards. It should not be marked on boiler shell until it is taken down from the riveting machine, as it sometimes happens, from different causes, that the shell becomes slightly twisted, and this would therefore alter the true level of the valve seats previously arranged. The manhole can always with safety—after being rolled up—be marked, drilled, and cut out and riveted at the machine if possible. A line can then be struck through its centre from end to end of the boiler, and the accuracy of the work so tested. Then the valve seats can be marked on without any possibility of error.

(*To be continued.*)

On Machine Designing.

[CONTRIBUTED.]

(*Continued from page 165.*)

(6.) EFFICIENT LUBRICATING ARRANGEMENTS.—The most common means of lubrication, but not the most efficient, is the provision of simple oil holes and grooves in the upper part of the bearing, the oil being occasionally poured into these at pleasure. Often, as in machine tools, where the workman is always present, this is sufficient, with ordinary care, but generally wasteful of oil. It is important that such oil holes should be so placed as to be readily accessible, or oil tubes led to them. The aperture should always be fitted with a removable oil plug to prevent the admission of dust. All slides should be provided with abundant oil grooves or channels, and oil holes leading to these.

Where machinery has to run without attention for a considerable time, automatic lubricating devices are essential. Thus, line-shaft bearings are usually fitted with needle lubricators, which give a constant small supply of oil so long as the shaft rotates and the supply holds out. Large engines are fitted with very efficient and quite elaborate lubricating arrangements, consisting of syphon oil boxes conveniently placed, having tubes leading to each bearing. The ordinary sight-feed lubricator, used in connection with steam engines, is a very effective apparatus for imparting to the entering steam a small but definite quantity of cylinder oil, thus reducing the friction of the internal parts.

(7.) ADJUSTMENTS TO COMPENSATE FOR WEAR.—All bearings over, say, 1½in. diameter which are subjected to much pressure should be fitted with gun-metal steps or "brasses," which can be removed after wear, the faces filed or machined, and set up again. They should bed metal to metal when the "cap" or "keep" is screwed down, so that there is no danger of "binding" on the shaft. The steps, if large, have usually a gun-metal liner fitted between them, which is eased according to the wear. Sometimes a hard-wood liner is fitted instead. This, by its elasticity, allows a greater range of movement of the top step before it becomes necessary to remove the liner for "thinning." As it is of vital importance that the shaft should bed well the full length of the bearing, the journal, during erection, is coated with a mixture of a red colouring matter known as "ruddle" with oil, repeatedly tried in position, and the step scraped until a satisfactory bearing is obtained. Bearings should be adjustable in the direction of the pressure—that is, of the wear. As this is sometimes in two directions—in crank-shaft bearings, for example,—it becomes necessary to make the bearings in three pieces; but often, for simplicity, two brasses divided diagonally are used instead, but this is hardly satisfactory. Small bearings have usually a gun-metal bush driven in tight, and further secured by a screw or plug, the bush being renewed when the wear becomes excessive. In certain positions, as in the framing of heavy tools, it is inconvenient to provide steps; then, quite large holes are thus fitted with gun-metal bushes.

Thrust bearings having a large number of collars are generally employed to receive a heavy axial pressure. These distribute the whole pressure over a considerable area, and thus reduce the pressure per square inch. Tailpins are used in lathes and other tools to receive the axial pressure, the bearing surfaces being of hardened steel; occasionally a leather washer is interposed between the surfaces. Conical bearings are used in many light lathes and drilling machines. The spindle and its bush are of mild steel, casehardened and ground with a revolving emery wheel to a good bearing. For adjustment the spindle is given a small axial movement by means of a pair of nuts; these are then locked. The adjustment must be carefully made, and the lubrication good, otherwise the surfaces will "seize." To reduce the probability of this occurring, the bush is often made of gun metal, but with a considerable sacrifice of durability. The thrust is not received on the conical bearing, but on the tailpin.

Long, light connecting rods should each be provided with an adjusting coupling nut, the rod being divided and the two ends screwed with a right-hand and left-hand thread respectively. The connection is made by a suitable long nut and lock nuts.

(8.) TELL-TALES AND INDICATING GEARS.—In elaborate mechanical arrangements, such as exist in connection with the propelling and other machinery of battleships, efficient means of communication between individuals somewhat remote must be provided. This necessitates a variety of telegraphs, indicating gears, tell-tales and dials connected by positive mechanism for transmitting oft-recurring or standard messages; also voice tubes, for less usual orders.

In the engine room of every steamship a tell-tale, actuated from the bridge, is fitted near the starting platform. The position of the pointer on the dial informs the engineer when it is desired to start or stop, to go full speed ahead or astern, to run half-speed or dead-slow; a bell is added to direct attention to its indications. Revolution counters are also conveniently connected to record the number of revolutions performed by the engines in any required time.

Every modern warship has a conning tower, constructed of armour several inches thick. This is fitted with dials, indicators and tell-tales in rich profusion, connected with various important parts of the ship. The tower represents the head; the guiding intelligence or officer within represents the brain; the connecting rods, shafts, and levers, are the nerves through which the orders are transmitted to the several muscles which execute the orders—namely, the men in charge of the machines.

Electric telegraphs and indicators are also now coming into use.

In all steam and hydraulic installations a number of pressure gauges must be conveniently located, to indicate the steam and water pressure respectively.

In machine-tool work it is usual to carefully graduate into degrees the tool boxes of planing, shaping and similar machines, as well as the slide rests of lathes, and the universal heads of milling machines, for the purpose of being able to quickly adjust to any angle.

(9.) LIGHTNESS.—To make a machine much heavier than its duty demands is folly; it is sheer waste of material, and often, besides, makes the machine unhandy. Unnecessary weight is especially objectionable in locomotive machinery, whether locomotives, marine engines, gun carriages, fire engines, travelling cranes, or bicycles. An exception occurs in the case of road-rolling engines, where weight is a desideratum. Engines for fast cruisers, gunboats, torpedo boats, locomotive and fire engines are models of lightness combined with efficiency.

In the reciprocating parts of high-speed machinery also lightness is a very desirable quality. At each reversal of motion the inertia has to be overcome, much to the disadvantage of the machinery in point of steadiness and the durability of working joints. Hence, in designing these, the weight should be reduced to the safe minimum, and pressures arranged to act, as far as possible, always in one direction, rather than alternating.

For the sake of lightness and strength, steel castings are now often used where cast iron was formerly wholly employed, as in the engines and machinery generally of warships.

The tendency of present-day engineers is to substitute plate work for castings, in order to gain lightness and a certain degree of flexibility. The disposition of material follows on the same general lines as in cast ribbed sections, but the structure is built up of plates and angles riveted together. The framing of steam hammers is an instance in point. The old cast-iron bedplates of the propelling, pumping, and training engines of battleships are also now completely superseded by light seatings of plate work, built into the structure of the ship.

(*To be continued.*)

Metal Trade Memoranda.

The output of ore from the Marbella Iron Ore Company's mines during the month of April was 1464 tons.

The Clay Lane Iron Company, Middlesbrough, have blown in another furnace in place of the one damped down a few weeks ago.

The export of gold from Cape Colony during the month of April amounted in value to £381,950, as compared with £430,000 last March and £402,000 in April, 1892.

Sir Alfred Hickman, with a view to increasing the output at his Spring Vale Furnaces, will shortly erect an additional hot-air stove and otherwise enlarge his plant.

The mines of the Arizona Copper Company produced during the month of April 322 tons of black copper and 77 tons of matte. This is equivalent to about 376 tons of black copper.

The Standard Steel Casting Company, Thurlow, Pennsylvania, have just completed and shipped an open-hearth cast-steel sternpost for the United States cruiser "Columbia," now in course of construction at Messrs. Cramp's shipbuilding yard. It is stated that this is the largest steel casting ever made in America. The casting is in one piece, and weighs 49,520lb.

The return issued on the 3rd inst. at Middlesbrough of the Cleveland ironmasters' stocks for the month of April gives an increase of 1700 tons, compared with 10,000 tons addition in March and an average of 37,000 tons each for December, January, and February. Stocks in warrants and makers' hands are 196,000. The April production was 228,000 tons, 6500 tons below March, 117,000 tons being Cleveland iron and the remainder steel-making iron. Eighty-seven furnaces were blowing, against 88 in March.

New Companies.

ALADDIN PRIMARY ELECTRIC BATTERY COMPANY LIMITED.—This company was registered on the 28th ult., with a capital of £6000, in £10 shares, to acquire by purchase the patent rights of Mr. T. Coad, and in a primary electric battery and electric miner's safety lamp, and to carry on the business of an electric light company in all its branches. The regulations of Table A apply in most cases. Registered by Stokes, Saunders and Stokes, 21, Great St. Helens, E.C.

RAINBOW ENGINEERING COMPANY LIMITED.—This company was registered on the 1st inst., with a capital of £20,000, in £5 shares, to acquire the goodwill of the business carried on at Albany Buildings, 39, Victoria-street, S.W., under the style or firm of "The Rainbow Engineering Company"; to enter into an agreement made between C. H. Rosher and J. C. Goodenough, and to carry on the business of electrical engineers and all similar trades. Registered, without articles of association, by J. B. Purchase, 11, Queen Victoria-street, E.C.

GEORGE HENDRY AND CO. LIMITED.—This company was registered on the 1st inst., with a capital of £3500, in £10 shares, to acquire and take over as a going concern the business of a coppersmith and brassfounder, heretofore carried on at Oak-lane Copper Works, Church-row, Limehouse, E., under the title of G. Hendry and Co., and to continue the above-mentioned business. G. Hendry, J West, and H. Lyon are to be the first directors; qualification, £200; remuneration, £10 per annum divisible; this does not refer to Mr. G. Hendry. Registered by Snow, Snow and Fox, 7, Great St. Thomas Apostle, E.C.

GEORGE COTTON AND CO. LIMITED.—This company was registered on the 29th ult., with a capital of £7000, in £5 shares, to purchase or otherwise acquire all patents and patent rights, with the freehold land, cottage, and workshop, all the erections, plant, and other things thereon, with the business and goodwill, now carried on at Willaston, near Crewe, Cheshire, under the style of "G. Cotton and Co."; and to carry on the business of agricultural engineers, ironfounders, etc. The number of directors is never to be less than 5, nor more than 7; Mr. George Cotton is the managing director of the company, with a salary of £156 per annum.

ZOHRAB AND BIGGS' ENGLISH PATENTS LIMITED.—This company was registered on the 1st inst., with a capital of £32,007, in 3200 deferred shares of £10 each, and 7 preference shares of £1 each, to purchase certain letters patent granted, or about to be granted, to Edward T. Zohrab and Edwin Joseph Biggs, as co-owners, for an invention relating to signalling on railways, and all improvements therein, and to establish factories for making, using, and perfecting the invention. The number of directors is not to be less than 3, nor more than 7; qualification, 100 shares; remuneration to be fixed in general meeting. Registered by Capel, Cure and Ball, 32, Fenchurch-street, E.C.

ALFRED HETHERINGTON AND CO. LIMITED.—This company was registered on the 3rd inst., with a capital of £12,000, in £1 shares, to purchase and work Hetherington's English patents for improvements made in drying hops, to acquire the Wey Ironworks, Alton, Hants, and to carry on the business of iron and brass founders, makers of agricultural implements, etc. The following gentlemen are to be first directors:—Wm. J. Nicholson, S. W. Seward, and A. Hetherington, who is to be the managing director, with a salary of £120 per annum and a bonus of 20 per cent. after the ordinary shareholders have received a £10 per cent. dividend. Registered by Jordan and Sons, 120, Chancery-lane, W.C. Registered office, the Wey Ironworks, Catpound, Alton, Hants.

The Metal Market.

PRICES CURRENT.

LONDON, May 8.

COPPER opened with a sale of a single cash warrant at Friday's closing value, and then rallied to £44 2s. 6d. under buying orders, but when these were placed prices tended lower, and £44 1s. 3d. was taken for cash, £44 2s. 6d. for a week, and £44 1s. 3d. for a few days prompt. Three months was done at £44 11s. 3d., and the market ruled quiet but steady during the afternoon, only 50 tons changing hands. Closing values are partially 1s. 3d. higher on the day. Sales, 400 tons. Settlement price, £44. English tough, £47 10s.; best selected, £48 15s.; strong sheets, £56.

TIN opened dull, and after a while became a shade easier, cash in a week passing at £92 15s. The markets showed little subsequent variation, and business was limited. Three months, however, fully maintained its value at £87 10s., and £87 5s. was paid in the afternoon for six months. The market closed steadily at a partial loss of 2s. 6d. for cash. Sales, 50 tons. Settlement price, £92 12s. 6d. English ingots, £95 10s. Amsterdam market firm, with Billiton at 54¾ and Banca 55½.

PIG IRON ruled inactive during the early session, bids of 40s. 6½d. cash in a week and 40s. 7d. ten days failing to move sellers. An easier tendency, however, later developed in sympathy with Glasgow, and 500 tons were put through at 40s 6d. for a few days prompt. Final rates are 1½d. lower for Scotch and Middlesbrough, while home is 9½d. down. Settlement prices:—Scotch, 40s. 5d.; Middlesbrough, 33s. 8d.; hematite, 44s. 7d.

TINPLATES are dull and unchanged. I. C. cokes, f. o. b. Swansea, 11s. 7½d.

LEAD is steady and about 1s. 3d. better. Spanish, £9 13s. 9d. buyers, £9 15s. sellers. English, £9 17s. 6d.

SPELTER is 2s. 6d. easier at £18 sellers, May shipment.

ZINC SHEETS.—Silesian are steady at £21 ex ship. Belgian remain steady. V. M. brand, £21 5s., ex ship, and £21 2s. 6d., f. o. b. Antwerp.

OFFICIAL CLOSING QUOTATIONS.

	To-day.					
COPPER—	£	s.	d.	£	s.	d.
G. M. B.—Cash	44	1	3—44		8	9
" Three months	44	11	3—44		18	9
TIN—						
Fine foreign—Cash	92	12	6—93		2	6
" " Three months	87	10	0—88		0	0
Australian—Cash	93	5	0—93		15	0

PIG IRON—

	Scotch. Cash. s. d.	Scotch. 1 m'th. s. d.	Middlesbrough. Cash. s. d.	Middlesbrough. 1 m'th. s. d.	Hematite. Cash. s. d.	Hematite. 1 m'th. s. d.
Close ...	40 5½	40 8	33 8	33 10	44 7½	44 9½
Prev. close	40 7	40 9½	33 9½	33 11½	45 5	45 7

GLASGOW, May 8.—The pig-iron market was more active, 30,000 tons Scotch being dealt in, 6000 at 40s. 7d. and 40s. 6½d. a month fixed, with 1s. forfeit in seller's option; and 17,000 tons fetched 40s. 6d. to 40s. 7d. cash, with sellers over at the cheaper figure; 4000 tons Cleveland sold at 33s. 8½d. cash, and 33s. 10d. one month. Nothing was done in hematite, but the cash price fell back 9½d. from Friday's close. The shipments of Scotch last week were 17,000 tons, being an increase of 1610 tons on the corresponding week, and making the increase for the year 4111 tons.

QUOTATIONS:—

	s.	d.
Scotch warrants—Cash	40	7
" One month	40	9
Middlesbrough—Cash	33	8½
" One month	33	10½
Hematite—Cash	45	0
" One month	—	

BIRMINGHAM, May 8.—There is a little more animation in the hardware branches on home account, the principal orders being from London and the North, but there is no improvement in prices. Wrought-iron tube manufacturers report business dull and depressed, owing not so much to the curtailment of demand as to the excessive keenness of competition, home and foreign. In this, as in the screw, wire, steel, and other branches, the Germans are underselling us considerably. Seamless steel tubes, however, continue in good request for cycle work, and most of the works devoted to this class of tube are in full operation. Prices and profits, however, are much reduced from the level of a year or two ago. The iron and steel wire trade is moderately active, and wire-workers may be reported fairly busy in netting, meshing, weaving, and chain work. Wire safes and dish covers also are in good demand. In steel cutting and grinding mills for coffee, grain, and beans, etc., local makers are well employed, mostly for South America and Eastern markets. Grocers' mills are in good request on home account. In lanterns, teapots, bath and toilet ware, and tin goods generally, trade is fairly good. The demand for sporting guns is improving, and magazine rifles are now being produced by machinery for sporting as well as for military purposes. A new development of electro-plating is a process for plating non-metallic substances by first covering them with a thin film of copper, which allows of the employment for decorative purposes of a great variety of natural objects, flowers, birds, leaves, and sprays of foliage.

Official Gazette.

Partnerships Dissolved.

F. ANDREW, T. BELL, E. M. BURTON, S. LOWE, J. RICHARDSON, C. K. TOMLINSON, H. MACKINDER, S. H. LOWE, F. CLENCH, and G. M'DAKIN CLENCH, general engineers, millwrights, iron and brass founders, boilermakers, and agricultural machine makers, Lincoln and elsewhere, under the style of Robey and Co.; so far as regards F. Clench and G. M'Dakin Clench.

S. RUBERY and T. W. RUBERY, iron merchants, Blockall, Darlaston, under the style of Samuel Rubery and Sons.

W. T. STURGESS and E. TOWLSON, engineers, millwrights, iron and brass founders, Norwich, under the style of Sturgess and Towlson.

Letters to the Editor.

**** We do not hold ourselves responsible for opinions expressed by correspondents.*

**** The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

**** Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

THE "CAMPANIA."

To the Editor of THE MECHANICAL WORLD.

SIR,—In the Miscellaneous Items of your issue for May 5, you state that the Cunarder "Campania" accomplished the voyage in 6 days 8hrs. 34mins., from Liverpool to New York, this being the record for maiden voyages. I think that is an error, because the German Liner, "Fürst Bismarck," when she ran her maiden trip from Southampton to New York, in 1891, covered the distance (3086 miles) in 6 days 14½hrs. Now, in comparing this with the "Campania" running her 2869 miles from Queenstown to New York, she is very much behind the "Fürst Bismarck," which vessel to this day has the record for the fastest maiden trip from England to New York. G. F. B.

Brighton, May 7.

TESTING AND ANALYSIS OF IRON AND STEEL.

To the Editor of THE MECHANICAL WORLD.

SIR,—We are obliged to "Looker-on" for pointing out the mistake in the article on "Testing and Analysis of Iron and Steel" in your issue of April 21, 1893. The composition of the ignited precipitate is Mn_3O_4, and the weight obtained $\times 0{\cdot}72052$ gives the weight of metallic manganese. We intend to give a second method in which the Mn is determined as MnO_2, and have accidentally placed the precipitate thus obtained under the bromine method. We trust that little inconvenience will have arisen, as the mistake is so very obvious.

LEADBEATER AND HODGSON.

Rotherham, May 8.

Prize Competition.

WE OFFER FOUR GUINEAS MONTHLY IN PRIZES FOR THE BEST ORIGINAL ARTICLES SENT IN ON ANY MECHANICAL, ENGINEERING OR ELECTRICAL SUBJECT.

IN ORDER THAT MANAGERS, DRAUGHTSMEN, FOREMEN, AND WORKMEN WHO HAVE HAD NO PRACTICE IN WRITING MAY NOT HESITATE TO SEND IN COMPETITIONS, IT IS TO BE UNDERSTOOD THAT ALL ARTICLES WILL BE FULLY EDITED AND CORRECTED, AND JUDGED OF SOLELY ON THEIR MERITS AS ORIGINAL CONTRIBUTIONS FROM A PRACTICAL POINT OF VIEW. THE OBJECT OF THE COMPETITION IS TO INDUCE PRACTICAL MEN TO COME FORWARD AND GIVE THE RESULTS OF THEIR EXPERIENCE.

CONDITIONS.

Competitions for our Monthly Prizes must be sent so as to arrive at the Manchester Offices of THE MECHANICAL WORLD, New Bridge-street, not later than the last Tuesday in each month. Articles arriving after that time will be placed in the following month's competition.

Written competitions must be on one side of the paper only. The contributions must be original, and relate to matters connected with Engineering, Mechanism or Electricity.

The Proprietors of THE MECHANICAL WORLD reserve the right to publish any competition, whether it gains a prize or not.

The competitions may be accompanied by diagrams, sketches or drawings.

Competitors should write the words "Prize Competition" on the envelopes.

Competitors are not confined to one, but may send any number of competitions.

The correct name and address of the sender *must* be distinctly written upon every competition, not necessarily for publication. Competitions can appear under a *nom de plume.*

☞ We cannot undertake to be responsible for any MSS. sent to us, though when stamps are enclosed for the purpose we will endeavour to return rejected contributions.

Miscellaneous Items.

An electric railway for passenger traffic is to be constructed from Douglas to Laxey, in the Isle of Man.

The Milan Council has authorised the Edison Company to run an electric tramway experimentally for a year. The length is two miles.

Belgrade is to be lighted by electricity. The standards which are to support the arc lamps are already in position in the principal streets.

Since the opening of the first Spanish railway in 1845, there has been opened a total of 10,002 kilometres, being an average of 238 kilometres per annum.

Mr. Clement E. Stretton, C.E., of Leicester, the special representative and consulting engineer in England of the Baltimore and Ohio Railroad, sailed from Southampton on the 7th inst. for New York, Baltimore, and Chicago.

It is stated that the Greek Government has decided to establish a telephone system in Athens, and also in the principal towns of Greece. A telephone line already exists between Athens and Piræus, a distance of about five miles.

The death is announced of Sir James Anderson, who was knighted in 1866 on the completion of the laying of the Atlantic telegraph cable. He was in command of the "Great Eastern" while that vessel was engaged in the work of putting the cable down.

The Canadian Pacific Railway Company have inaugurated a new route to Australia and New Zealand, *via* Vancouver and Honolulu, and the steamers "Miowera" and "Warimoo," 5000 tons each, belonging to the New Zealand and Australian Steamship Company, will be engaged in the service.

At the ordinary meeting of the Institution of Civil Engineers, held on the 2nd inst., Mr. Harrison Hayter, president, in the chair, a paper was read containing a description of the system of "Mining and Ore Treatment at Broken Hill, N.S.W.," by Mr. M. B. Jamieson, Assoc. M. Inst. C.E., and Mr. J. Howell.

The English mails for Australia were last week delivered in the colonies in the shortest time ever known. The Peninsular and Oriental Company's new steamer, "Australia," arrived at Adelaide on the 4th inst., at 1 p.m., with the mails which left London at 8-30 p.m. on Friday, April 7. The time of transit was 26 days, 16 hours, and 30 minutes.

Further particulars have been received from the officials of the South-West Africa Company in Damaraland with regard to the recent discovery of a large copper outcrop north of Otavi. They describe it as the finest mineral outcrop they have ever seen. The survey taken gives the length as 500 to 600ft. in height, and in breadth from 20 to 30ft. The district is rich in copper associated with argentiferous lead ore.

An extensive discovery of gold is reported at Willow Springs, Southern Oregon, U.S.A.

On Saturday, the 6th inst., in the Physical Lecture Theatre of the Durham College of Science, Newcastle, Principal Garnett was presented with two electrical measuring instruments by the students who have attended the winter series of lectures on "The Pioneers of Electricity," as a mark of appreciation of his efforts for their instruction.

An electric crane is to be erected on Southampton Town Quay. A few days since a deputation from the Southampton Pier and Harbour Board visited the works of Messrs. Stothert and Pitt, at Bath, and witnessed the testing of the crane; this was done with a weight of two tons, hoisting and slewing at the same time, and the trial proved in every way satisfactory.

The largest centre of telephonic communication in the United Kingdom, and one of the largest in Europe, is that of Liverpool, where the National Telephone Company have just completed their new switch room. This is a hall 90ft. in length, and is fitted in a way which completes nearly a million of telephonic connections, whereby each subscriber on the exchange may be placed immediately in connection with any other throughout the country. Already there are worked from the Liverpool centre 9600 miles of line, of which more than 7000 are exchange and private wires. In 1882 the mileage of wires in Liverpool was only 463 miles; in February last it was 7019. From the last published statistics it appears that the number of "calls" in the Liverpool centre is 42,800 per day, representing a daily communication between 95,600 persons.

Queries.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

JIGS FOR DRILLING.—The Americans often use what is termed a jig for drilling. Will anyone kindly give a sketch, together with drill? —DRILLER.

CHURCHILL SLIDE VALVE.—Can any correspondent inform me who are the makers of the "Churchill Patent Slide Vale"? Any information would be thankfully received.—J. M.

RETEMPERING EDGE TOOLS.—Will any reader inform me if there is any method of tempering pattern maker's chisels and gouges that have been burnt in a pattern-shop?—CYMRO.

WARSOP AERO STEAM ENGINE.—Any information about the working of the above engine, tried about 1870, such as the effect on the boiler, cylinder, piston rod, etc., will oblige —M.R.

CLEANING BOILER TUBES.—Will some reader describe a useful tool to remove hard, thick scale from cross tubes in a vertical boiler? Tubes 9in. diameter and 4ft. 6in. long.—NOVICE.

CLEANING GALLOWAY TUBES.—Can any reader inform me of some acid with which I could remove thick scale from a number of Galloway tubes which are not accessible by scrapers?—BOILER.

GALVANISING.—Can any reader inform me whether it is possible to do galvanising on a small scale, say 3 or 4cwt. spelter bath? also the process of preparing cast-iron work for the bath?—T. J.

CASE-HARDENING FURNACE.—Will any practical reader give a sketch of a good furnace for case-hardening purposes, cutter-heating, etc., gas, liquid fuel, or coke, or the name of any maker of such?—LISTER AND CO., Keighley.

KEYS, COTTERS, ETC.—Can anyone inform me what kind of steel is used for making keys and cotter pins as used on most engines? The keys that are bought seem to be of better quality than the so-called mild steel as sold at very little more than the price of fair merchant iron.—STEEL.

STEAM REVERSING GEAR.—I should be much obliged if any reader will explain the working of a steam reversing gear for locomotives, which I have seen on the following railway companies' engines:—Glasgow and South-Western, Mersey Tunnel, and South-Eastern. A sketch would assist me.—F. TURTON.

THEORETICAL DIAGRAMS.—Will any reader sketch and describe the theoretical indicator diagrams which would be obtained from a set of triple-expansion engines, having given —Load on safety valves, 150lb.; height of barometer, 30in.; ratio of cylinder volumes, 1, 2½, 5; total ratio of expansion, 8.—HYPER.

METALLURGICAL FURNACE.—Can any reader furnish me with a scheme for supplying the heating power necessary for a metallurgical laboratory situated in iron-ore mining district, and where no gas is available? A small muffle furnace would be required, in addition to the ordinary heating power, and the fuel used is charcoal. Accommodation only required for one chemist.—H. S.

WIRE ROPE TRANSMISSION.—I want to transmit 60H.P. from a turbine running at 400 revolutions per minute, by a travelling wire rope to a mill main-shaft running at 250 revolutions, distance 100yds., and at 70yds. from turbine, a right-angle bend. There is a slight rising gradient from motor to mill. Will someone kindly tell me size of pulleys to use, diameter or circumference of rope, and speed? Can I drive direct without an intermediate gearing or countershafts? What is the best method of turning the angle, and should one or more ropes be used?—MINER.

DYNAMO WINDING.—Can any reader oblige me with the proper winding for an E.P.S. type dynamo of the following dimensions (in centimetres), so as to obtain at least 4 volts 3 ampères at a speed of about 2000 revolutions per minute:—Length of magnet bar, 11; length of yoke piece, 8·4; width of magnet and yoke piece, 5·3 each; depth of yoke piece, 2·5; thickness of magnet bar inside bobbin, 3; diameter of armature, 5; length, 5·3; air gap, ½ millimetre all round? It has a laminated armature, with 12 interruptions $\frac{3}{16}$in. wide by ¼in. deep, and a corresponding number of sections in the commutator. The magnets are of Swedish cast iron. I have tried it with 2000 turns of No. 38 B.W.G. on the field and 120 turns of No. 26 B.W.G. on armature, but can get hardly any current.—E. P. S. TYPE.

FEED PUMPS.—In working out feed pumps for common high-pressure engines, Molesworth says, p. 493—"Take cubic contents of cylinder and one steam passage and multiply by 4, and divide by proper specific volume for given pressure." Why multiply by 4? There are only two cylindersful of steam discharged to one revolution or one stroke of the pump. Then, again, should not the cubic contents of cylinder be taken to cut off only? For instance, if steam is cut off, say, at half-stroke, and initial pressure be 100lb., the specific volume for which is 270, we find a great difference from the plan of taking the full cylinder at the average pressure, which at 100lb. initial pressure will be 75 average, the specific volume for 75 being 353, not to mention the difference in the two cubic capacities. Feed pumps worked out according to Molesworth's rule and others always come out much too large—nearly three times. I shall be glad if some reader will explain this.—COLD WATER.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

L. V.—No address given.

GAS.—There is no work on the subject.

DRAUGHTSMAN (Glasgow).—Many thanks for your letter and suggestions, which shall have our best attention.

WOOD'S AUTOMATIC PRESSURE RELIEF VALVE.—Required the address of Messrs. W. Wood and Co., the makers of the above.—B. AND CO.——*A.*—The address of above makers is W. H. Wood and Co., Cradley Boiler Works, Cradley Heath, Staffordshire.—Y. D.

LOCOMOTIVE STAY TAPS.—Can any reader furnish me with the addresses of firms who are makers of locomotive stay taps suitable for fireboxes?—GEORGE.——*A.*—If "George" will write to Widdowson, Britannia Works, Ordsal-lane, Salford, he will get any sort of tap he may require.—LOCO.——*A.*—"George" should write to J. C. and R. Tidswell, Victoria Works, Palmerston-street, Ancoats, Manchester.—Y. D.

POWER RENTAL.—I am desirous of supplying steam power to a tenant from an engine driving his own works. How is the value of such to be ascertained, and what is the fair price for 100I.H.P. per week of 54 hours; also for 8I.H.P. similarly supplied?—POWER.——*A.*—This question, to be properly dealt with, requires more details than supplied, but if the writer would communicate with me through your paper I would do my best to answer him.—Y. D.

BRIGHTENING CHAINS.—Can any correspondent inform me what material to use in a shaker to brighten chains?—W. B.——*A.*—W. B. would find emery powder and oil answer his purpose.—Y. D.——*A.*—Chains are brightened in a very effectual manner by using ordinary smithy scales and leather shavings in the shaker. The shavings are procured from the tanners, and used slightly damp. The quantity can be found by experiment, the proportions being about bulk for bulk. I do not know whether the above is used at the present time, as I have had nothing to do with chain-making for at least 20 years.—OTTO (Liverpool).

DYNAMO.—Can any reader inform me whether a dynamo, wound to give 10 ampères at 55 volts at a given speed, would be damaged if driven at twice the speed; and, if not, what output would it give?—J. O.——*A.*—If the machine is series wound the E.M.F. alone will be increased, and machine will at double the speed give double the output (approximately). The lamps would have to be changed to 110-volt lamps, or two 55-volt lamps put in series. If the winding is shunt wound it would not do to over-run the machine as suggested. In any case it is a question whether the armature will stand, in continuous work, the strains due to centrifugal force that would be developed at the higher speed.—A.I.E.E.

TRACTION ENGINE.—Occasionally it is necessary to fit a new face on to the old face in steam chests on which slide valve works, in traction and other engines. What kind of metal is used in such a case?—FACE.——*A.*—The metal used for refacing slide valve faces depends upon the thickness of the false face you fit on. If ½in. thick, you might safely use cast iron, care being taken to see that it is thoroughly bedded down to the old face before inserting the screws, otherwise you may crack it. If less than ½in. thick I should advise brass.—FIDELITY.——*A.*—Any ironfounder will supply you with a good close-grained casting free from blowholes, which, after machining, may be secured in the usual way either by cheeseheaded set pins or brass studs riveted over flush.—OTTO (Liverpool).

FACING SLIDE VALVE FACES.—I require a hand appliance, not expensive, suitable for getting up the faces of slide valves of portable, traction, and other engines, say when the valve face is some 3in. to 5in. from the valve-chest cover face. Are there no small hand-lever appliances which can be screwed on to a stud and used for working a broken file or similar tool?—NESCIENCE.——*A.*—If you have a large number of similar valve faces to keep in order, a suitable machine might be constructed to work as you suggest, taking a light cut with a sharp V-tool, finishing off by hand with a suitable scraper; or a milling device might be made to take a cut of about ⅜in. wide each setting, one cut to overlap the previous one to about ¼in. For odd sizes, however, and different makes, of engines the outlay would be out of proportion to the result.—OTTO (Liverpool).

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

24th April, 1893.

8197 ELECTRIC DISTRIBUTION APPARATUS. W Aldred.

8202 BALL BEARINGS APPLIED to the WHEELS and AXLES of RAILWAY ROLLING STOCK and ROAD VEHICLES. E B Ivatts.

8205 PULLEY BLOCKS. J T Pickering.

8211 FORMATION or CONSTRUCTION of BLADES or SAWS for SAWING or CUTTING STONE. J T Riddiough.

8218 BRAKES for RAILWAY WAGONS. F F Williams.

8223 MACHINERY for SHAPING WOODEN HANDLES.* R G Burleigh.

8230 STEAM ENGINES.* A Knudsen.

8231 SCREW PROPELLER.* A D Hall and G B Sloan.

8237 ARRANGEMENTS for the CONVEYANCE of the WASTE PRODUCTS of COMBUSTION and STEAM from the LOCOMOTIVES of UNDERGROUND RAILWAYS.* G Dalton and G Bray.

8240 BEARINGS. M Williams.

8247 ENGINE INDICATORS. M J Wayne.

8249 LOCKING SCREW NUTS. J T Marsh.

8251 STEAM GENERATORS. P M Justice. (*La Société Anonyme du Générateur du Temple*, France.)

8253 APPARATUS for PLUMMING and LEVELLING. G S A Crocker.

8257 AUTOMATIC CIRCUIT-BREAKERS.* D Irish.

8258 STEAM ENGINES. V V Damme.

8261 ACTUATING CRANES by GAS or OIL ENGINES. H H Wake and W C Mountain.

8263 COOLING the PISTONS of ENGINE CYLINDERS. Tuxen and Hammerich.

8264 COUPLING for ROPES.* A Wenk-Wolff and O Strohbach.

8265 TELESCOPIC EXTENDING LADDERS. I T Cross and V F Thomas.

25th April, 1893.

8279 TAPS. W G Gas.

8280 GAS or OIL ENGINE. F G Jones.

8284 LOCKING NUTS. T Collier.

8288 AUTOMATIC ANGLE PLOTTING and RANGE FINDING INSTRUMENT. T B Shaw.

8294 STEAM BRICK and TILE PRESS. J Gill and J W Burns.

8304 SAFETY LAMP. W Lewis.

8313 MECHANICAL MOVEMENT.* A Anderson. (*The Singer Manufacturing Company*, United States.)

8315 SWITCHES for ELECTRIC CURRENTS. New and Mayne.

8316 ELECTRICAL PROPULSION of BOATS. New and Mayne.

8317 HEATING of FEED or SUPPLY WATER for STEAM BOILERS. A Miller.

8324 OVERHEAD or ELEVATED RAILWAYS.* L F Cook.

8330 ELECTRIC CAR BRAKES.* M E Company.

8332 JOINTS for RAILS.* A J Moxham.

8333 INTEGRALLY UNITING a RAIL and SUPPORT.* A J Moxham.

8336 ROLLER BEARINGS*. D Young. (*The Copeland Roller Bearing Company*, United States.)

8343 MACHINES for FORMING and DRIVING WIRE STAPLES.* H H Lake. (*E R Johnson*, United States.)

8346 SMELTING of ORES and REFINING of METALS.* C M Allen.

8351 APPARATUS for LOCKING RAILWAY POINTS or SWITCHES.* E Weisskopf.

8353 ORE-CRUSHING MACHINERY. T Thompson.

8357 ROTARY TURBINE ENGINES.* R Haddan. (*J H Dow*, United States.)

8359 LOCKING DEVICES for SECURING the NUTS of BOLTS in POSITION AFTER BEING SCREWED UP. O L Mobbs.

8361 NAIL. G F Restall.

8369 APPARATUS for TREATING SMOKE.* H E Newton. (*B R Harrington*, India.)

8371 APPARATUS for the MANUFACTURE of CARBURETTED WATER GAS.* L L Merrifield and others.

8372 HEAT-STORAGE RADIATORS for STEAM HEATING.* E E Gold.

8374 DIFFERENTIAL GEARING. W Aubert, jun.

8377 STEAM PUMPS. P E Hodgkin and H J Fox.

26th April, 1893.

8381 MACHINERY for the MANUFACTURE of CORRUGATED MATERIAL for PACKING. H Tee.

8382 STOP VALVES. A Dawson and F W Thomas.

8389 METAL for the BEARINGS of ROTATING SHAFTS. M L Sykes.

8391 ELECTRIC BELLS. C Turnbull, jun.

8392 CORDITE LOADING MACHINES. G Kynoch and Co. Limited and E Jones.

8398 DRIVING GEAR for OPERATING the TOOL CARRIAGES of LATHES. W H Murton and W S Varley.

8402 BELTS and THEIR FASTENINGS. J B Brooks.

8406 AUTOMATIC ATTACHMENT APPLICABLE to STEAM BOILER FURNACES. P Roscow.

8409 GAS, OIL, and LIKE POWER MOTORS. G Wilkinson.

8411 INSTRUMENT for USE with SHIPS' COMPASSES for DETERMINING DEVIATIONS, ETC.* W P Thompson. (*C T E Clauson*, Denmark.)

8414 BELTS for DRIVING, ELEVATING and WINDING. R B Jones and others.

8421 LOCK-NUTS. T C Roussel.

8427 APPARATUS for REGULATING ELECTRIC CURRENTS. L B Miller and M W Woods.

8431 SAW BLADES.* G Székely.

8432 TRANSMITTING MOTION at VARYING SPEEDS. F Hughes. (*E Gervaise*, France.)

8434 INSTRUMENT for MEASURING the FLOW or VELOCITY of WATER or LIQUIDS in MOTION. J W McLaren.

8436 CONTROLLING or REGULATING the SUPPLY of ELECTRICITY. G Martin.

8437 PULVERISER and AMALGAMATOR. J H Holman and T H Tregoning.

8442 WHEELS for RAILWAYS or TRAMWAYS. J J D Cleminson.

8444 RAILWAY and TRAMWAY POINTS. W Howell.

27th April, 1893.

8456 MANUFACTURE of STEEL, and the REFINING of FLUID IRON. B H Thwaite.

8458 RAILWAY CHAIRS. G Davis.

8475 ADJUSTABLE SPANNERS and WRENCHES. G J Haden and others.

8477 VALVE GEAR for DUPLEX DIRECT-ACTING STEAM PUMPS, ETC. W H Holehouse.

8484 REVERSING VALVE BOXES for REGENERATIVE GAS FURNACES. J J Kelly.

8487 SMOKE-CONSUMING APPARATUS. H T Grainger and J P Clark.

8500 MOTOR GOVERNORS.* E H Atkinson.

8502 ELECTRICAL RAILWAYS and TRAMWAYS.* W L Wise. (*A Diatto*, Italy.)

8506 TRIP MOTIONS for OPERATING CORLISS VALVES of FLUID-PRESSURE ENGINES. G N Brearley.

8509 SHIP CONSTRUCTION.* W von Schirach.

8510 PROCESS for the MANUFACTURE of OIL GAS. J Moeller.

8514 CONVERTING CONTINUOUS INTERMITTENT ROTARY MOTION, APPLICABLE to LACE MACHINERY. E Cope.

8517 LUBRICATOR for HYDRAULIC MACHINES. G Andrews.

8519 STOVES, STEAM GENERATORS, and OTHER APPARATUS DIRECTLY HEATED by the COMBUSTION of COAL or OTHER FUEL.* J Wetter. (*H Baysen* and *O N Sörensen*, Denmark.)

8525 COMBINED STEAM and VAPOUR ENGINES. E G Behrend.

28th April, 1893.

8529 CONSTRUCTION of CHAIN LINKS. G H Gardner. (*F W Smith*, United States.)

8532 WATER GAUGES for STEAM-GENERATING BOILERS. H Roberts and S Hird.

8540 DRIVING BELTS. W Ranstead.

8550 STARTING TRAMCARS or OTHER VEHICLES. R Starke and J Darling.

8551 LUBRICATORS.* R Bombe and F Schuchhardt.

8567 PORTABLE ELECTRIC LAMPS. O March.

8568 BELTING and DRIVING BANDS.* J Nayler and A Barrs.

8569 TAP for STEAM and LIQUIDS. J Peatfield.

8571 CELLS for ELECTRIC BATTERIES. H C W Emery.

8572 PROCESS for PREPARING IRON or STEEL for TINNING, GALVANISING, ETC. R Clayton.

8576 APPARATUS or MACHINES for FORMING or SHAPING METALLIC ARTICLES. W P Thompson. (*F Feldhaus*, Belgium.)

8578 FRICTION CLUTCHES. I and C L Braithwaite. (*The Dodge Manufacturing Company*, United States.)

8582 CAR COUPLERS. R S Robertson.

8584 DESILVERISING LEAD. R S Garton. (*P Naef*, United States.)

8589 SAFETY GUARD for the FRONT of LOCOMOTIVE ENGINES. L Martineau.

8591 SCREW PROPELLERS. L C Gueit.

8600 CONTINUOUS-CURRENT DYNAMO-ELECTRIC and ELECTRO-DYNAMIC MACHINES. A I Gravier.

8602 AUTOMATIC BLOCK SIGNALLING APPARATUS for RAILWAYS. A Scremin and others.

8607 SHIP'S DAVITS. R Roper.

8608 SHIP'S DAVITS. R Roper.

8609 SHIPS, and RAFTS for the SAME. R Roper.

8610 SHIPS, and RAFTS for the SAME. R Roper.

8611 BOAT-DISENGAGING GEAR. R Roper.

8612 BOATS. R Roper.

8613 SHIPS, and RAFTS for the SAME. R Roper.

29th April, 1893.

8618 MULTIPLE CHANGE-OVER MECHANISM for ELECTRIC ARC LAMPS. W J Davy.

8619 MACHINE for PUNCHING, DRAWING, or COMPRESSING METALS. J R Hill.

8626 WIRE STRIP TAPE TUBES and SHEETS MADE from COPPER, ALLOYS, or STEEL. W J Warren.

8628 BELTS for DRIVING MACHINERY. W Ranstead.

8629 BELTS for DRIVING MACHINERY. W Ranstead.

8635 STEAM HAMMERS.* J Bêché, jun.

8639 HYDRO-CARBON ENGINES. J A Drake.

8648 RATCHET or OTHER BRACES for DRILLING, BORING, REAMERING, ETC. T Haggart.

8649 TELEGRAPH INSULATORS. J Morris.

8653 RAILWAY SIGNALLING or CONTROLLING APPARATUS. A J Boult. (*J N Dechaine* and *A Becker*, Belgium.)

8654 ELECTRIC ARC LAMPS. W J Davy.

8667 UTILISATION of FEED-WATER for STEAM BOILERS for PERFORMING WORK on SHIPS. C C Daevel.

8671 CONTROLLING COMPRESSOR VALVES. F A Robinson and G A Goodwin.

8675 GALVANIC BATTERIES. R J Crowley and J R Grant.

8676 COUPLINGS for RAILWAY CARRIAGES. J Hart and A Mounteney.

8679 HYDRAULIC and PNEUMATIC MOTORS. M W Lowinsky.

8680 VENTILATION. W C Toone.

8681 WATER GAUGES and SIMILAR INDICATORS. J Finlay.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to SIR H. READER LACK, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

All who are practically engaged in Mechanical Engineering or Scientific Industries are invited to avail themselves of THE MECHANICAL WORLD columns for information. We are glad to help the diffident, and, so far as we can, remove the obstacles which frequently prevent practical men from communicating their ideas.

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Every correspondent should forward his name and address, not necessarily for publication unless so desired. We do not undertake to return MSS. unless specially requested, and in such cases stamps should always be sent.

All communications relating to editorial matters should be addressed to the Editor of THE MECHANICAL WORLD, at the Manchester, and not the London, Offices.

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IMPORTANT NOTICE.

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The actual sale of "The Mechanical World and Metal Trades Journal" is now greater than that of all the other recognised Engineering Journals put together.

FRIDAY, MAY 19TH, 1893.

Indicators for Gas Engines.

FEW practical engineers will dispute the assertion that under ordinary circumstances the indicated horse-power of a steam engine is not a very reliable measure of the power of the motor. The care exercised in the design and construction of modern indicators has done much to improve matters, but unfortunately this does not by any means remove all the sources of error. We repeatedly come across glaringly inaccurate reducing gears, while the amount of piping which some so-called engineers employ in making the connection between the instrument and the cylinder bears very eloquent testimony to their ignorance of the first principles of indicator practice. But the errors, whether preventible or otherwise, which invalidate the power measurement of steam engines, sink into insignificance when compared with the difficulties encountered in indicating gas and oil engines. The working conditions in the latter case certainly call for very much better instruments than are at present available, and it is certainly surprising that among the many makers of high-class instruments, no one has successfully met this "long-felt want" by introducing a reliable gas-engine indicator. Of course, many makers of repute supply special instruments for the purpose, but these do not give universal satisfaction by any means. Under present conditions the principal causes which work such havoc with instruments of ordinary construction are the excessive heat and the violence of the explosion of the charge. As a result of the first, lubrication of the piston is rendered difficult, if not impossible, and the contrast with the condition of the instrument when used on a steam cylinder is very marked. In this latter case, lubrication of the piston presents no difficulty, provided a suitable grade of oil is employed, while in addition the water of condensation, which is supposed to accumulate in the grooves of the piston, forming the so-called "water packing," also assists to this end. But in indicating gas engines a temperature perhaps six or eight times as great as that met with in the steam engine has to be dealt with, and it is therefore not surprising that lubricants are burnt up, and that pistons bind and become set fast. Moreover, when indicator springs are secured to the heads by solder, the melting of the latter is a frequent cause of trouble. Thus, in a recent test of a 100H.P. Otto gas engine made by Mr. H. W. Spangler, and reported at length in the "Journal of the Franklin Institute," so much inconvenience was experienced from this cause that the indicator had to be removed from the cylinder after taking each diagram. The second source of difficulty above referred to—the violence of the explosion—has wrecked many a valuable instrument, the pencil bar suffering severely in most cases, though occasionally fracture of the spring occurs. Thus in the test just referred to, the instruments first used were abandoned, as both springs and pencil bars failed owing to the suddenness and violence of the explosion. Taking all the facts into consideration, it will, we think, be admitted that gas-engine indicators should, in the first place, be of the pistonless type. Such instruments have frequently been brought forward for steam-engine work, but for this purpose their advantages are few, and at best of a very doubtful character. For gas engines, however, they appear to offer a partial solution of the problem which will have to be met in the near future. One objection formerly urged against pistonless indicators—the difficulty of varying the strength of the spring or its equivalent,—does not apply in the case of the gas engine, as the conditions of pressure, expansion, etc., are tolerably uniform. As to the best form for the instrument, this can only be determined by experiment and experience; but without forgetting the Bourdon tube arrangement, we may remark that at least one Continental firm of high repute make a pistonless indicator for ammonia refrigerating machines, etc., which would appear to lend itself admirably to the purpose. This has a corrugated diaphragm in place of a piston, the pencil movement being an adaptation of the Thompson arrangement, but with a much larger multiplication of the motion of the piston than usual. There is an urgent need of a good instrument for gas-engine work, and the problem is certainly worthy of the best attention of engineering-instrument makers generally.

Electric Lighting in Leeds.

ANOTHER central electric-light station, on the system generally adopted by the various house-to-house electric-light companies, has been inaugurated, this time at Leeds. After a policy of procrastination the Corporation let the opportunity pass away of municipalising the supply of electric light, and the Yorkshire House-to-House Electric Light Company stepped in, and have now commenced operations. The redeeming feature is that the town has the right of acquiring the undertaking on certain terms when it becomes successful. Actual lighting was commenced at the close of last year with the preliminary plant put down to accommodate consumers pending the starting of the permanent station, which took place last week. The works are laid out on the Lowrie-Hall high-tension system, with current in the distributing mains at 2000 volts, and 100 volts in the establishments lighted. The plant comprises three boilers of the Lancashire type fitted with mechanical stokers, and constructed for a working pressure of 140lb.; two Fowler compound horizontal condensing engines of 200H.P., and one of 100H.P. of the same type; and two alternators of 100 kilowatts and one of 50 kilowatts. The alternators, which are driven by ropes, are excited by means of continuous-current dynamos arranged on their shafts. The cables are laid underground in cast-iron pipes, and transformers are placed at intervals for reducing the 2000-volt current to 100 volts for lighting. There are three main distributing circuits, and the most distant part lighted is situated two and a half miles from the generating station. The present capacity of the station is 15,000 incandescent lamps, of which 7000 have already been connected. The opening ceremony, or the switching on of the current to the lamps for the first time from the permanent plant, was performed by the Mayor of Leeds (Alderman Ward) on the 10th inst., in the presence of a large assembly, not only of electrical engineers and members of the Leeds Town Council, but also representatives of other corporations about to introduce the electric light.

The Working of Steel.

SOME observations on the working of steel were recently made by Mr. Greiner, who considers that the forging of steel is nothing else than a kneading, the effect of which is to increase the homogeneity of the metal. A block of cast steel consists, in fact, of hard elements connected by less resisting magmas. It follows, from this heterogeneous agglomeration, that test pieces cut from the same cast block may show very different degrees of strength, according to the arrangement of the hard elements; and the metal of such test pieces, when subjected to tensile strain, can only stand a slight elongation. To obtain greater homogeneity and give a regular grain to the metal, two methods may be adopted, one by internal and the other external action. The first consists in tempering and hardening, in which the metal, raised to a red heat, is allowed to cool slowly, or is dipped in oil, lead, or other substance. During the cooling or immersion a special grouping of the molecules occurs, which gives to the metal both homogeneity and resistance. The method by external action consists in giving blows to the metal with the steam hammer, or kneading it by the press. Under the action of the hammer the surface of the block of metal becomes elongated, and a harder coating is formed thereon, which cools rapidly and prevents the action of hammering from reaching the heart of the ingot, although still hot. In this manner a hardened skin is formed round a soft core. The action of forging presses, on the contrary, is transmitted more directly to the ingot, the sides not pressed of which assume a convex form, while under the action of shock they become concave. As the surface cools much less rapidly than under blows from the hammer, the working of the metal during a single heat may be prolonged considerably.

Electricity in Agriculture.

TAKING into consideration the present applications of electricity to practical purposes and to its (apart from lighting and traction purposes) somewhat restricted sphere of operations for other objects at the moment, it is not surprising that inquiries made in different parts of the world concerning the use of electricity for working agricultural machinery and implements, and in assisting the growth of plants, should result in obtaining information of little value at the present time. Such is the result of the endeavours of the United States Government, who about a year ago commissioned their consuls and commercial agents in various countries to report upon the utilisation of electricity as a power in the operation of farm machinery and implements, and in the propagation of plants. It is in the latter direction that the largest amount of experimental work has been done, and Germany and France seem to take the lead. In the former country Helmert commenced as early as in 1859; he was followed by Fichtner, Tschinkel, and Professors Wollny and Holdefleisz, the latter two in 1883 and 1884 respectively. Mr. C. W. Siemens' work in 1880 must, however, not be forgotten, neither must that of the late Sir William Siemens in 1880, and which was dealt with in a paper which he read before the (then) Society of Telegraph Engineers and Electricians. Widely different results have been obtained by the experiments as to the influences of the electric current upon vegetation, and also of the electric light on vegetation. So much is this the case that electricity cannot be regarded as a practical commercial factor in this direction. The same state of affairs is shown by the replies concerning the operation of agricultural machinery and implements by electricity, there being almost the world over no applications of electricity to this purpose. Naturally enough, more attention has been and is being paid to the commercial uses of electricity rather than to experimental work in agriculture or horticulture, but the latter will doubtless receive due consideration at some future time.

Lighting of Malta.

IT is probable that tenders will at no distant date be invited for the construction and equipment of a central electric-light station at Malta, for the supply of 10,000 incandescent lamps. Mr. W. H. Preece, F.R.S., who has investigated the matter, and embodied the results in two reports to the Council of Government, states that with the exception of the Strada Reale, the streets of the four cities are very badly lighted, and that the Government is paying a high price for a poor service of gas illumination. He impresses upon the Council the advisability of undertaking the supply of electric light on its own account; and if this suggestion is adopted, electrical illumination will be provided, according to Mr. Preece, at a rate cheaper than gas; and the lighting of the streets will be improved fourfold by electricity at the same price as now paid for gas. Plans and specifications are being prepared for dealing with the four cities and Sliema. These plans are divided into three parts—(1) for Valetta and Florian; (2) the three cities; and (3) Sliema and Hamrun. The total cost of the central station is calculated at £40,000, whilst out of an estimated annual revenue of £10,000, no less than £7000 is guaranteed by the War Department and by the Maltese Government. In case the Council of Government undertakes to establish the works at its own expense, the names of various English, Continental, and American firms who have created a reputation for good work are mentioned as likely to tender for the contract; but they would have nothing to do with the enterprise if they had to provide the money for laying down an electric-light system. The suggestions of Mr. Preece will doubtless be adopted, and in that event a remunerative contract will be open for competition.

Machine Construction.

THE CONSTRUCTION OF MACHINE ELEMENTS.

(*Continued from page 163.*)

§ 167.

GRAPHOSTATIC CALCULATIONS FOR SINGLE OVERHUNG CRANK.

THE crank is such an important detail of machine construction that it demands a most careful discussion, hence a graphostatic investigation of the stresses in it is here given.

The Crank Axle.—Having calculated d and l, draw the skeleton diagram of the crank—that is, the neutral axis A B C D E, Fig. 464, in which B C represents the axis of the crank arm, which in this case lies normal to the axis of the shaft, and is placed in its proportional distance from the centre of the crankpin A, and from the bearing D. Then lay off the force P from a, normal to E a, choose the pole O of the force polygon (this being placed upon a line passing through the end of P and parallel

to the axis E a), draw the ray a d O, and line d E, also the ray O P_1 parallel to d E; then a d E will represent the cord polygon for the bending which P produces upon the axle a C E, and P P_1 represents the force upon the journal E, and P_1 a the force upon the journal D. Also make a F equal to the crank radius R, draw F G, and this latter will be the twisting moment (§ 140) which P exerts upon the axis. This moment M_d may be combined with the bending moment M_b, to give for each point an ideal bending moment,

$$M_i = \tfrac{3}{8} M_b + \tfrac{5}{8} \sqrt{M_b^2 + M_d^2} \text{ (see § 45),}$$

from which the polygon curve $c' d' e'$ and surface of moments C c' d' e' E are obtained. From the latter, in combination with the pin diameter d, and ordinate t of the base of the pin, the diameter of the shaft may be obtained according to formula (124).

The Crank Arm.—Prolong E a to a_0, and transfer the cord polygon D a d to the base line B C—that is, make the angle a_0 B C = the angle D a d, and then will B a_0 C be, with horizontal ordinates, the surface of moments for the bending of the crank arm due to the force P. Also make C c_0 = B b_0 = C c, then will the horizontal ordinates of the torsion rectangle B b_0 c_0 C be the moments with which P acts to twist the crank arm about the axis B C. This moment may again be combined with the bending moment to give an ideal moment as before; (a_0 $a' = \tfrac{3}{8}$ a_0 C, draw B a', make at any point H, the space H $i = \tfrac{5}{8}$ B b_0, and make H $h = h_0$ h' + h' i) which gives the surface of moments B b' h F C for the crank arm. From this and from the diameter d and ordinate t, we can construct the conoidal form of the arm I K L M, according to formula (124). From this, again, the profile S T U V of an arm of rectangular section may be derived, the width h being assumed for any point and the corresponding thickness b obtained from the value y of the conoid, according to the formula :—

$$\frac{b}{y} \quad 0{\cdot}6 \left(\frac{y}{h}\right)^2 \qquad \ldots\ldots\ldots\ldots(156)$$

in using which, the second table of numbers at the close of these articles will be found useful. If the position of the axis B C does not give satisfactory results, the operation must be repeated with a better relation of parts. By proceeding in this manner the dimensions of a crank and axle may be so determined that they will be equal in strength to the pin upon which the power is exerted.

In the preceding diagram the crank arm was taken as normal to the axle. A slight inclination may be neglected, but if the angle is greater, as shown in Fig. 460, it should be so considered in the diagram. The procedure is then as follows (Fig. 465): The diagram for the crank shape is constructed as before, the portion under a b being used only for the shank A B of the crankpin, and the portion under C E being combined as before with the torsion moment, to obtain the surface of moments C c' d' e' E.

The crank arm is again subjected to bending and twisting; the lever arm is now B′ C, A B′ being made normal to the axis B C of the crank arm, the bending polygon being a portion of the triangle C B′ C′, in which the angle at B′ is equal to the angle d a D. The twisting force acts with a lever arm A B′; the moment is obtained by drawing an ordinate at a' normal to B C, B′ a' being taken equal to B′ A. The combination of moments gives the surface of moments B b'' c'' C in the same manner and of the same use as in the preceding case.

§ 168.

CAST-IRON CRANKS.

The crankpin is sometimes made spherical instead of cylindrical. Such a one is shown in Fig. 466 on a cast-iron crank. The sphere will be of suitable diameter if described from the middle of a normally-proportioned overhung crankpin without making allowance for shoulder. The crankpin is secured by cold-riveting the end in place—an excellent method and one often used. The I-formed section can be proportioned by the use of the table in § 164. When h is taken as equal to the hub diameter, the cross section sometimes works out too light to be suitable for casting, and in such cases it must be increased according to judgment. Sometimes cast-iron cranks are made simply by laying out the proper hubs for the shaft and crankpin, and then joining them by an arm of rectangular section.

If it is desired to employ the graphostatic method, the dimensions may first be determined for a wrought-iron crank of rectangular section, and then doubling the depth (see § 162) for cast iron, and obtaining the proportions for I-formed section according to § 164.

§ 169.

THE RETURN CRANK.

A return crank is one which is formed upon the pin of an ordinary overhung crank, returning back toward and having rotation about the same crankshaft as the main crank. Fig. 467 shows a wrought-iron crank otherwise similar in construction to the one shown in Fig. 463. Frequently the return arm is on the same line as the main crank, as shown in the illustration, but in many cases it is differently placed. The arm and pin of the return crank are similar in shape and proportions to an ordinary overhung crank. The arm of the main crank demands no especial consideration, when, as is usually the case, there is but little pressure on the pin of the return crank. The main crankpin must be determined separately. It is subjected both to bending and to torsion. For this purpose the formula (154) is to be used, remembering that when the return crank is driven by the main crank the moment of the return crank is greatest in the middle of the main crankpin.

(*To be continued.*)

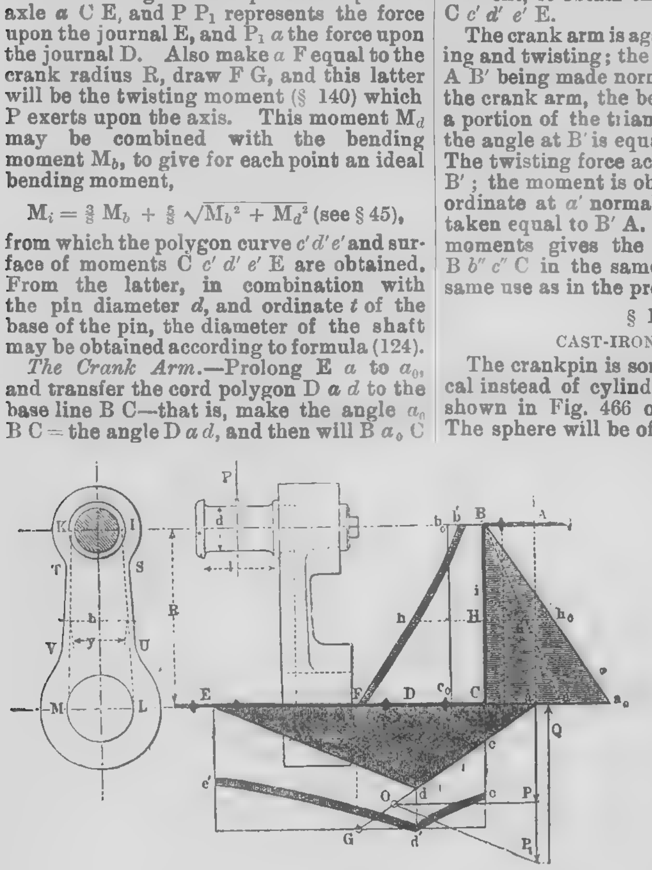


FIG. 464.

MACHINE CONSTRUCTION.

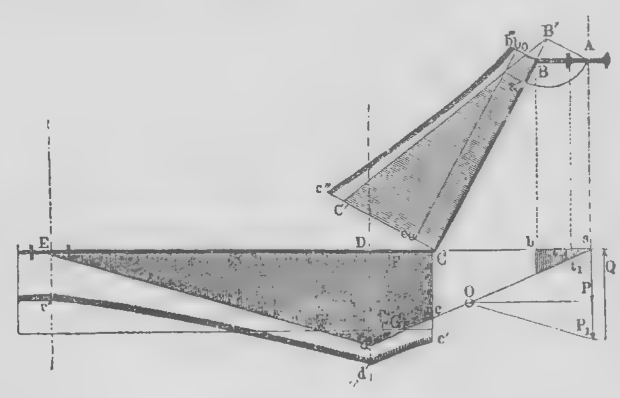


FIG. 465.

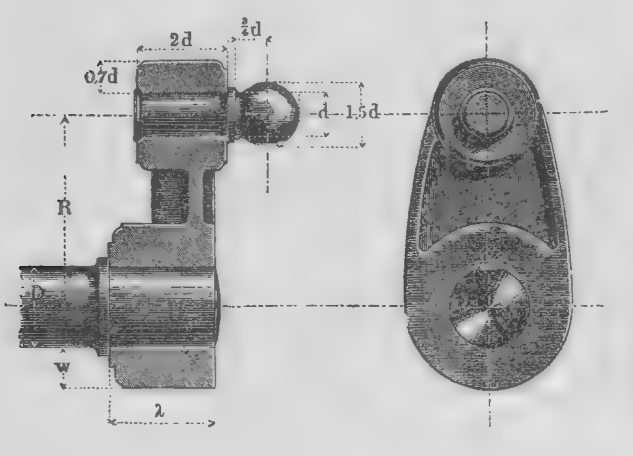


FIG. 466.

MACHINE CONSTRUCTION.

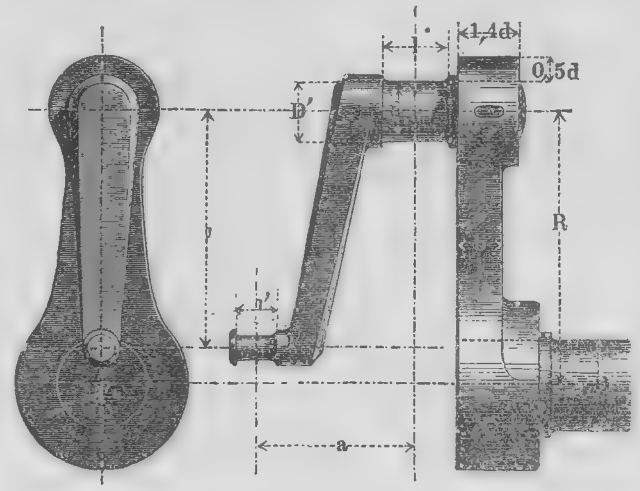


FIG. 467.

Mechanical and Engineering Drawing.—XIII.

BY A PRACTICAL DRAUGHTSMAN.

IN the foregoing problems under the head of "Projection," we have given all the positions which it is possible for a line to occupy with reference to its planes of projection, and we could at once proceed to the projection of *plane figures*, were it not necessary at this stage that the student should thoroughly understand the true significance of the line lettered I L in previous and all future diagrams under the heading of "Orthographic Projection."

This line, we have already shown, is the line of intersection of the two "planes of projection"; but it is much more than this. The V P and H P, being for all the future purposes of the student draughtsman represented by the *one* flat surface of his sheet of paper, with the I L either shown on it or assumed to be there, dividing its surface into two planes, it becomes —when *shown in* on a drawing or explanatory diagram — at one and the same time the representative, not only of the I L, but of the V P and H P as well, for it is a plan of the V P and an elevation of the H P, and as these it is a *datum* line from which heights *above* the H P, or distances *from* the V P, may be measured or set off.

These facts, it will be seen, are verified by a reference to Fig. 72. Here the I L is for al the figures, a *plan* of the V P, showing the line A b by its plan to be parallel to the V P, and in front of it, at a distance equal to A a. Similarly C, the lower end of the line C p, is shown *touching* the V P, while its upper end p, projected into t in the H P, stands *out* from the V P a distance equal to t t', and *above* the H P a height equal to t' p. Then again F e is the height of the line E F above the H P, the end F touching the V P in e, and the end E being a distance equal to E F from the V P when in the first position, and a distance equal to f h when in the second. In the two last cases, it will be seen that the I L is a plan of the V P and an elevation of the H P. With the foregoing explanation of the projection of lines thoroughly digested, the student should have no difficulty in finding the projection of plane figures, to which we now proceed.

Projection of Plane Figures.—Knowing how to find the projections of a line having any given position with respect to the planes of its projection, we can now proceed to the projection of those straight-sided plane figures which form the surfaces of the solids used in giving shape to machine details. As the same principles apply to the projection of all plane figures, whether their sides are few or many, it is only necessary that their application should here be shown in the case of one of each class of figure chosen. Commencing with that figure having the least number of sides—the triangle—we shall give as additional subjects for projection the square, rectangle, pentagon, and hexagon, or those which usually form the sides and ends of the plane solids we have before referred to. Our first problem in this subject is :—

Problem 22 (Fig. 73).—The line a c is the plan of an equilateral triangle, with its base resting on the H P, and parallel to the V P; it is required to find its elevation or vertical projection?

Here, as the base of the triangle is parallel to the V P and its plan is represented by a *line*, the triangle itself is parallel to the V P, and therefore perpendicular to the H P. To find its elevation, through a and c draw projectors perpendicular to the I L, cutting it in A and C; through A and C with the 60° set square draw lines intersecting in B, join A, C, and the figure A B C is the required vertical projection of the triangle of which the line a c is the plan. The projection, it will be seen, is an *equilateral* triangle, for all the sides of the triangle being by the conditions of the problem parallel to the V P, they are projected on that plane into lines of the same length.

Problem 23 (Fig. 74).—To find the elevation of the triangle obtained in the previous problem when it is inclined 45° to the V P, its plan being the line a c, as before?

Here the I L may be considered as a plan of the V P. If we draw a line (with the 45° set square) of a length equal to a c, at an angle of 45° with the I L, that line will be a plan of the triangle A B C when at that angle with the V P. Bisect a c in b, through b draw a projector perpendicular to the I L, and from B, in Fig. 73, another parallel to it, cutting the one drawn from b in b'. Then, from a and c draw projectors to the I L, cutting it in a and c, join a' b', a' c', c b; the figure a' b' c' is the required elevation of the given triangle inclined 45° to the V P. In this case it will be noticed that the elevation obtained is an *isosceles* triangle, resulting from the altered position of its original with respect to the V P, the plane of its projection. The line a c is bisected in b to find the plan of the vertex B of the triangle A B C, Fig. 73; and the vertical projector through this bisection b determines, by its intersection with a parallel one through B, the elevation b' of the vertex in its new position.

Problem 24 (Fig. 75).—The line a c is the elevation of an equilateral triangle having its base touching the V P and parallel to the H P; to find its plan or horizontal projection?

The position of the original figure, of which the line a c is the elevation, is in this case the converse of that in Fig. 73. Here a c being a line in the V P parallel to the I L, the triangle whose projection it is must be parallel to the H P. To obtain its plan let fall from a, and c its ends, projectors perpendicular to the I L, cutting it in A and C, and through A C with the 60° set square draw lines intersecting in B, then the figure A B C is the required plan of the triangle of which a c is the elevation.

Problem 25 (Fig. 76).—Let the triangle obtained in the last problem be inclined to the H P at 45°, its base resting on that plane at right angles to the V P, and one angular point touching the V P; to find its projections in that position?

Assume the position of the triangle at first to be perpendicular to both the V P and H P; its elevation will then be a line perpendicular to the I L, equal to the altitude of the triangle, as C p; and its plan, a line A C, also perpendicular to the I L and equal to the base of the triangle. If, then, the triangle be moved on A C as a hinge (to the right) through 45°, its elevation at that angle is found by drawing—with the 45° set square—through C a line C B equal to C p. To find the plan, bisect A C in a, and through a draw a line parallel to the I L: let fall from B a projector perpendicular to the I L to cut the line drawn through a in b, join C b and A b, and the figure C A b is the projector of the triangle A B C (Fig. 75) when inclined at 45° to the H P.

Problem 26 (Fig. 77).—Given a straight line b c parallel to the I L as the plan of a square resting with one of its sides on the H P; to find its elevation? The plan of the square being a line parallel to the I L, the square itself will be parallel to the V P and perpendicular to the H P; therefore, from

b and c draw projectors perpendicular to the I L, cutting it in A and D; set off on one of them a distance A B equal to b c in the plan, and through B draw B C parallel to the I L; join A D, and the figure A B C D is the required elevation of the square whose plan is the line b c.

Problem 27 (Fig. 78).—To find the elevation of the square obtained in the last problem when it is inclined at 30° to the V P, its plan being a line b c, as before?

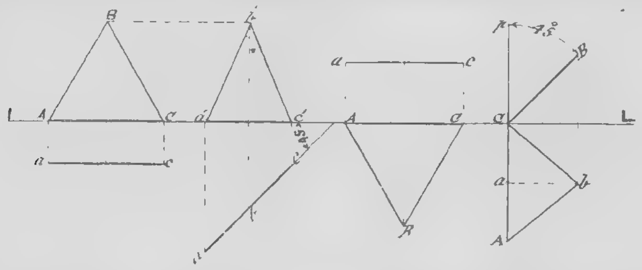


Fig. 73. Fig. 74. Fig. 75. Fig. 76.

Draw in the H P (with the 60° set square) a line b c—the plan of the square —making an angle of 30° with the I L; and from b and c draw projectors cutting the I L in a′ and d′, make a′ b′ equal to b c, and through b′ draw b′ c′ parallel to a′ d′, then the figure a′ b′ c′ d′ is the elevation required.

Problem 28 (Fig. 79).—A square with one of its sides touching the V P is represented in elevation by a line b c parallel to the I L; to find its plan?

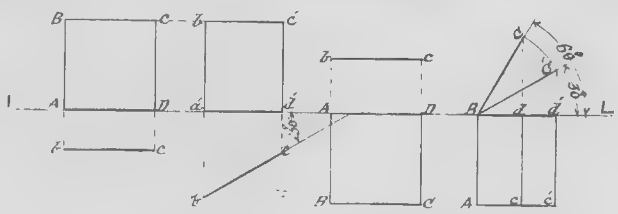


Fig. 77. Fig. 78. Fig. 79. Fig. 80.

From b and c let fall projectors perpendicular to the I L; make A B equal to b c, and through B draw B C parallel to the I L, join A B C D, and it is the required plan of the square.

Problem 29 (Fig. 80). — The square A B C D obtained in the last problem is inclined at 60° and 30° to the H P, with one of its sides touching the V P and an adjacent side the H P; to find its plan and elevation in those positions?

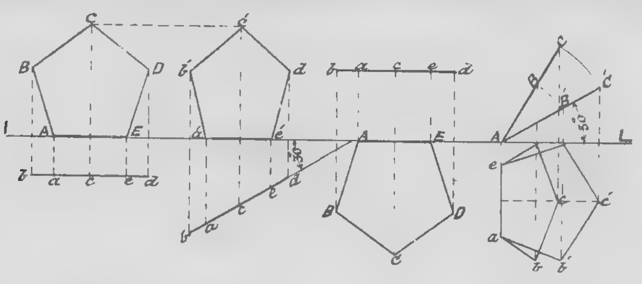


Fig. 81. Fig. 2. Fig. 83. Fig. 84.

At B in the I L, draw B C, B C′ (both equal to A B) with the 60° set square, making angles of 60° and 30° with the I L; then B C, B C′ are the required elevations of the square at those angles. From B d d′, draw B A, d c, d′ c′, perpendicular to the I L, and each equal to B C; and A c c′ parallel to it; then B A c d; B A c′ d′ are the plans of the given square when inclined at 60° and 30° to the H P. The projections of the rectangle are not given, as the method of obtaining them is in all respects the same as that for the square, but allowing for the difference of length of adjacent sides.

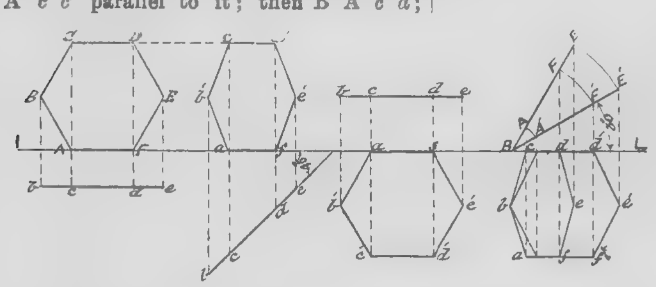


Fig. 85. Fig. 86. Fig. 87. Fig. 88.

· The method of obtaining the projections of a pentagon and hexagon in different positions with respect to the V P and H P is fully shown in Figs. 81 to 88, and will not need explanation further than to say that the elevations in Figs. 81 and 85—shown with reference letters in capitals—must be drawn *first*, according to the construction rules given in Problems 19 and 20, before their plans can be found; in all other respects the procedure is the same as in the previous figures.

To make himself thoroughly conversant with the application of the principles of projection to the delineation of plane figures, which it is most important he should be before passing on to the projection of solids, the student should draw all the foregoing plane figures at least twice, making them three times the size here given.

(To be continued.)

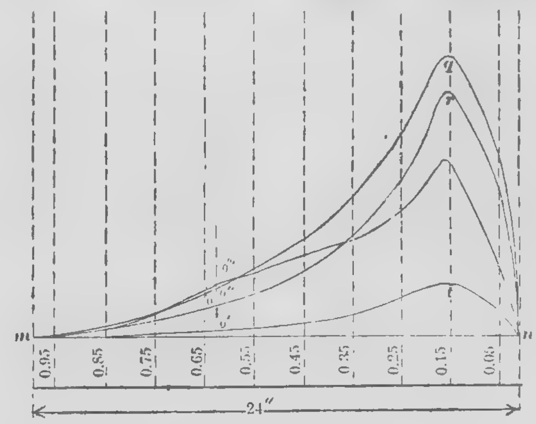
Principles, Possibilities, Curiosities and Limitations of the Crank Motion.—V.

FURTHER use of the Table II. is exemplified in the following solution of a practical example.

Example.—The diagram Fig. 5 is constructed, after a formula of Grashof, for pressures and volumes of steam at 135lb. per square inch initial, absolute pressure, or 120·3lb. unbalanced pressure (in a noncondensing engine), cut-off being at ⅛ stroke. The scales to which the diagram (a purely theoretical one) is drawn are, for pressure, 1in.=50lb., and for stroke 1½in. =1ft. The pressures marked over the ordinates are absolute; they measure the ordinates from the vacuum line to the expansion curve. The formula named allows for the presence of 10 per cent. of water by weight admitted to the cylinder with the steam, as an average, which average, however, since Grashof wrote his formula, has been diminished through the use of separators, increase of speed, and better insulation of pipes, the increase of speed being a potent factor in lessening the water inducted, as the steam being conveyed to engines more rapidly, and in much greater volume proportionally to the exterior surfaces of induction pipes, has a less proportion of its weight condensed on its way to the cylinder.

The initial pressure is high; steam at this pressure ought to be used in a triple or quadruple-expansion engine for highest economy; but, as in making the comparisons between the effects of long and short connecting rods, the differences become more pronounced with high pressures, and the effect of short cut-off in its relation to long and short rod lengths is also a point that should be made conspicuous. I have selected this high initial pressure as best suited to the purpose. The stroke is 24in.

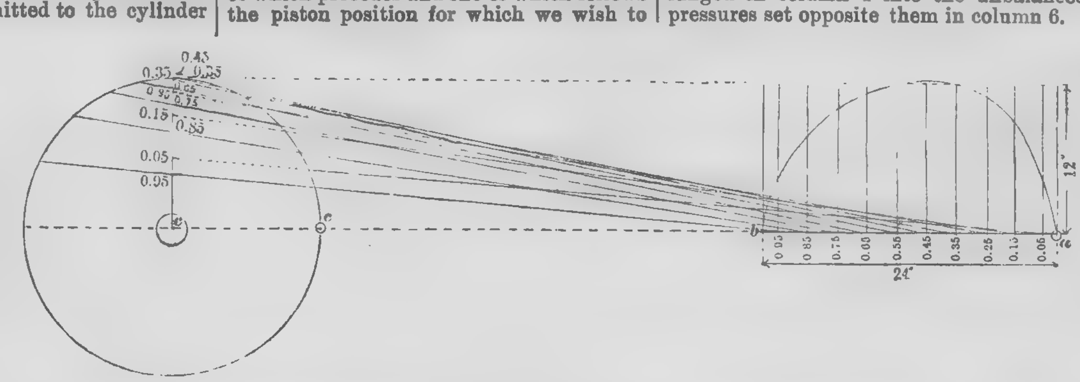
It is required to find first the rotative efforts per square inch of piston at points 0·05, 0·15, 0·25, and so on for each additional 0·10 of the stroke between the beginning and point 0·95 inclusive; and also the pressure on the slides for the same points, for an engine having a connecting rod radius five times the crank radius or $\frac{\text{crank radius}}{\text{rod radius}} = 1\cdot5$; and also for an engine having a rod radius 1⅓ time the crank radius $\frac{\text{crank radius}}{\text{rod radius}} = \frac{1}{11\cdot8} = 8\cdot9$; second, to find the average rotative effort for each engine, friction and other passive resistances being for the present left out of account in computing the rotative efforts.



Crank Motion.—Fig. 6.

Solution.—The rotative effort at the zero point of the stroke (both beginning and end of the stroke, since each stroke begins at the end of the previous stroke) is nothing. The unbalanced steam pressure per square inch of piston in position 0·05, Fig. 5, is found to be 92·25lb. from compression curve up, and this, multiplied by 0·472, the coefficient of rotative effort for a rod five times the length of the crank for the point in question (taken from column 48 in Table II.), gives the product, 43·54, or the rotative effort per square inch of the piston at this point. Similarly multiplying the same unbalanced pressure by the coefficient of rotative effort for point 5 and for a connecting-rod radius 1⅓ time the crank radius, taken from column 8 in Table II., this coefficient being 0·577, we get 69·66lb. as the rotative effort for point 0·05 of the stroke and for this radius of crank radius to rod radius.

We find that points 0·15, 0·25, 0·35, etc., are not comprised in Table II., and that we shall have to find coefficients of rotative effort and pressure on slides for them in the manner explained in the last article; that is to say, we find respectively the arithmetical means of the coefficients of rotative effort and pressures on slides for two piston positions given in the table, one of which precedes and one of which follows the piston position for which we wish to interpolate a coefficient, taking these arithmetical means respectively as the coefficient sought. It will be found very convenient to tabulate all the results as they are found, after the manner of Table III., which contains answers to the example given for all points.



Crank Motion.—Fig.

Thus for position 0·15 and for the case $\frac{\text{crank radius}}{\text{rod radius}} = 1\cdot5$, we find the mean of the coefficients of rotative effort for points 0·10 and 0·20 (as given in column 48 of Table II.) is 0·7500, and set this product in column 1 of Table III. Proceeding thus to find each of the interpolations, and taking out the coefficients given in Table II. for points 0·10, 0·20, 0·30, etc., we get the complete columns of coefficients in columns 1, 2, 3, and 4 of Table III.

The fifth column of Table III. can be completed from the pressures marked on

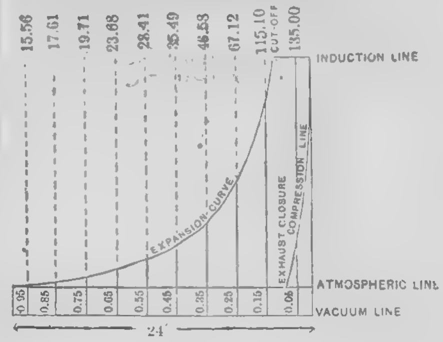


Fig. 5.

the diagram Fig. 5. The sixth column, except for point 0·05, is obtained by subtracting 14·7 from each number in column 5, the pressure of the atmosphere at sea level being 14·7lb. The unbalanced pressure represented by the ordinate for point 0·05 is found by measuring with the scale of pressure the distance from the vacuum line to the intersection of the ordinate with the compression line, and subtracting the pressure so found from the absolute initial pressure. It is 92·25lb. The seventh column is obtained by multiplying

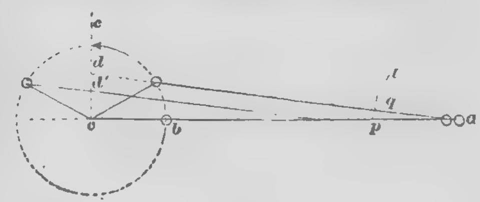


Fig. 7.

the numbers in column 1 by those set opposite them in column 6. The eighth column is found by multiplying the numbers in column 2 by those set opposite in column 6. The ninth column contains the products of the numbers in column 3, multiplied by the numbers set opposite them in column 6. Lastly, column 10 is filled out by the products of the coefficients ranged in column 4 into the unbalanced pressures set opposite them in column 6.

I anticipate the criticism that the interpolated coefficients obtained by taking the arithmetical means of the coefficients in Table II. are not exact, and admit the fact without hesitation. They are, however, so near an approximation for all the positions between points 0·10 and 0·90, that the total error will be slight; and the results will be sufficiently reliable for anything but strictly scientific purposes.

If now we set off on the corresponding ordinates in Fig. 5 (using the scale of pressures 1in. = 50lb.) the numbers (all representing pressures in pounds per square inch of piston) tabulated in columns 7, 8, 9, and 10 of Table III., measuring from the atmospheric line above which the pressures are

unbalanced by back pressure against the exhaust, and trace curves through the points, we get the curves of Fig. 6, *n q m*, *n r m*, *n s m*, *n t m*. These curves are respectively *n q n*, a curve of the rotative effort for $\frac{\text{crank radius}}{\text{rod radius}} = 1·5$; *n r m*, a curve of rotative effort for $\frac{\text{crank radius}}{\text{rod radius}} = \frac{1}{1\frac{1}{8}} = 8·9$; *n t m*, a curve of pressures on slides for $\frac{\text{crank radius}}{\text{rod radius}} = 1·5$; and *n s m* a curve of pressures on slides for $\frac{\text{crank radius}}{\text{rod radius}} = \frac{1}{1\frac{1}{8}} = 8·9$.

As above remarked, these curves vary a little from strict accuracy.

We can test the amount of variation by a graphic method.

Rankine was the first, I believe, to demonstrate that the coefficient of rotative effort on the crankpin of an engine, for all lengths of connecting rod, is found as shown in Fig. 7, in which the line *a b* represents the connectingrod (*a* being the crosshead pin and *b* the crankpin) and *b c* the crank radius, *c* being the centre of the crankshaft.

On a line *c e* drawn through the centre of the crankshaft, at right angles with a straight line joining the centre of the piston and the crankshaft centre, find the distance *c d'* or *c d* (where, at any assumed position of crosshead pin, as *h* or *k*, the centre line of the connecting rod, or this line produced, cuts the line *c e*. Then as crank radius in inches is to *c d'* or *c d* in inches so is the effort, or total pressure on the crosshead pin (exerted in the direction of the arrow for the out-stroke and the reverse for the in-stroke) to the rotative effort, or pressure on the crankpin exerted in the direction of rotation.

Hence, if in Fig. 8 we draw the stroke-line of the crosshead pin, and erect thereon ordinates from points 0·05, 0·15, 0·25, etc., then measure the crank length by any scale, and measure the line *c d'* or *c d* corresponding by same scale, for any particular ordinate, the latter as a numerator, and the former as a denominator, will express the coefficient of rotative effort as a common fraction; and this fraction reduced to decimal form will give the coefficient of rotative effort for that ordinate, as shown in Table II.

In Fig. 8 let *a b* be the stroke line traversed by the crosshead pin, *b c* connecting rod radius, *c c'* the crank radius, all drawn to the scale 1½in. = 1ft.

Let the crank radius be one foot and the rod radius five feet.

With *c'* as centre, and radius one foot, draw the path or circle described by the centre of the crankpin. Next erect the ordinates on the stroke line at points 0·05, 0·15, 0·25, and so on of the stroke. With the foot of each ordinate so drawn, as a centre, and connecting-rod radius, find successively the positions of the crankpin corresponding to each point of the stroke, and draw lines joining the crankpin position with the corresponding crosshead position. Now measure successively by any convenient scale the distances from the crankshaft centre to the points where these lines cut the perpendicular *c' e*, set them down successively as numerators of fractions, and write the length of the crank radius measured by the same scale as a denominator common to each of the numerators. These fractions are the coefficients of rotative effort. Multiply the unbalanced steam pressure in pounds per square inch represented by each ordinate successively into the corresponding coefficient of rotative effort, and set off the product by the scale of pressures used for the steam diagram, on the ordinate for which the coefficient was determined. Lastly, through the points marking the measurements of the products on the ordinates, draw a curve smoothly joining these points, and this will be a curve of rotative effort, accurate to the limit of skill in drawing and measuring by scale.

Analogously we may lay out on the steam diagram the curve of pressures on slides; but the coefficients we must use for this purpose are differently found. To get them, take the centre of the crosshead pin in each of its positions, and with the crank radius describe an arc *p l*, Fig. 7, cutting the line *a b*. From the point where this arc cuts the straight line that joins the crankshaft centre and the centre of the piston, erect the perpendicular *p q*, and using the same scale as was employed in finding the coefficients of rotative effort, measure the distance from the point *p* to the point *q* where the perpendicular cuts the line joining the crankpin centre with the crosshead-pin centre. Do this for all the crosshead positions, and take these measurements as numerators of fractions, each of which has the crank radius for its denominator. These fractions will then be the coefficients of pressure on the slides for the different positions. To find the total pressure on the slides at each point multiply the unbalanced steam pressure at the particular point by the corresponding coefficient. Set off on the stroke line these products successively, as obtained, on the corresponding ordinates, and through the points of set-off sweep a smooth curve. This will be a curve of pressure on slides.

Once obtained for any steam diagram, these curves enable the rotative effort and pressure on the slides to be directly taken off by the scale of pressures for any intermediate point whatever.

Thus let it be required to determine in our steam diagram these data for the point 0·63 of the stroke. The stroke being 24in. we find 0·63 of 24in. to be nearly 15⅛in. (decimal 15·12 in.); and measuring off this distance on the stroke-line (Fig 6) as accurately as we can, we locate the point at *o*. Now, drawing the perpendicular *o o' o'' o'''*, and measuring *o o''* and *o o'''* by our scale of pressures we find *o o''* × 16lb. and *o o'''* = 17lb., these being respectively the rotative effort per sq. in. and the pressure on slides for $\frac{\text{crank radius}}{\text{rod radius}} = 8\ 9.$

Similarly for $\frac{\text{crank radius}}{\text{rod radius}} = 1·5$ we get by measuring $o\ o_4$, the rotative effort = 9·5lb. and the pressure on slides = *o o'* = 2lb.

TABLE III.

STEAM AT INITIAL *absolute* PRESSURE OF 15LB., CUT OFF AT ¼ STROKE.

Piston Positions.	1 Coefficients of Rotative Effort for $\frac{\text{Crank Radius}}{\text{Rod Radius}} = \frac{1}{5}$	2 Coefficients of Rotative Effort for $\frac{\text{Crank Radius}}{\text{Rod Radius}} = \frac{1}{1\frac{1}{8}} = \frac{8}{9}$	3 Coefficients of Pressure on Slides for $\frac{\text{Crank Radius}}{\text{Rod Radius}} = \frac{1}{5}$	4 Coefficients of Pressure on Slides for $\frac{\text{Crank Radius}}{\text{Rod Radius}} = \frac{1}{1\frac{1}{8}} = \frac{8}{9}$	5 Steam Pressure at Ten different Piston Positions, Initial Pressure being 135lb. absolute.	6 Unbalanced Steam Pressure at Ten Points of Stroke.	7 Rotative Efforts per square inch of Piston for $\frac{\text{Crank Radius}}{\text{Rod Radius}} = \frac{1}{5}$	8 Rotative Effort per square inch of Piston for $\frac{\text{Crank Radius}}{\text{Rod Radius}} = \frac{8}{9}$	9 Pressure on Slides per square inch of Piston for $\frac{\text{Crank Radius}}{\text{Rod Radius}} = \frac{1}{5}$	10 Pressure on Slides per square inch of Piston for $\frac{\text{Crank Radius}}{\text{Rod Radius}} = \frac{8}{9}$
0·00	0·0000	0·0000	0·0000	0·0000						
0·05	0·4720	0·5790	0·0800	0·2850	135·60	92·25	43·54	53·41	7·38	26·29
0·10	0·6510	0·6000	0·1110	0·4320						
0·15	0·7500	0·8710	0·1360	0·5455	115·10	100·40	75·30	87·45	13·65	54·77
0·20	0·8490	1·1420	0·1510	0·6590						
0·25	0·9075	1·2255	0·1645	0·7385	67·12	52·42	47·57	64·27	8·62	38·75
0·30	0·9660	1·3090	0·1780	0·8180						
0·35	0·9900	1·3350	0·1845	0·9535	46·58	31·88	31·56	42·56	5·95	30·40
0·40	1·0140	1·3610	0·1950	1·0390						
0·45	1·0145	1·4210	0·1990	1·2025	35·49	20·79	21·10	29·54	3·83	25·01
0·50	1·0150	1·4810	0·2030	1·3160						
0·55	0·9835	1·4110	0·2030	1·4410	28·41	13·71	13·48	19·35	2·78	19·76
0·60	0·9720	1·3410	0·2030	1·5640						
0·65	0·9195	1·3350	0·1900	1·6845	23·68	8·98	8·26	11·99	1·79	15·13
0·70	0·8370	1·3290	0·1950	1·8030						
0·75	0·8040	1·2440	0·1840	1·8710	19·71	5·01	4·03	6·23	0·92	7·54
0·80	0·7610	1·1800	0·1730	1·9390						
0·85	0·6520	0·8605	0·1525	1·8170	17·61	2·91	1·89	2·50	0·44	3·43
0·90	0·5530	0·5510	0·1320	1·6950						
0·95	0·4775	0·2810	0·0980	1·2500	15·56	0·86	0·41	0·41	0·08	0·51

This graphic method serves to show the geometrical basis of the coefficients given in the table; but unless the diagrams are drawn on a large scale, and measurements are made very carefully, the curves will not be as accurate as can be obtained by use of Table II. For ratios of rod radius to crank radius other than those comprised in the tables, the graphic method can be advantageously used.

Finally, the mean rotative effort per square inch of piston area can be found by adding the numbers in columns 7, 8, 9, and 10 of Table III., and dividing by the number of different piston positions for which these columns were calculated; in our case there are ten of these positions.

Comparison of the rotative effort of the shorter connecting rod with that of the longer, shows that it is less for the longer rod. The shorter rod is not therefore more effective.

This chapter of the discussion may prove rather dry, but it should not be without interest to any engineer not already familiar with the principles and methods explained, and who wishes to know all the true inwardness of the crank motion.

The Relations of Chemistry to Foundry Practice.—I.*

CHEMICAL ANALYSIS has for its objects the detection and estimation of the constituent parts of material substances. That it proceeds upon an original separation of compound substances into the elementary substances composing them, and upon a positive identification of these, is an inference readily derived. This process began in an original way, and then became selective. The metals were early discovered to be elementary. As far as our present purpose is concerned, from the nucleus of metals—gold, silver, copper, and iron—sprung the long list of elements we now have —64. In later years this has been still further increased. The prolonged, arduous work that established the identity of a single element would make a history of experiments. It would likewise be a history of the patience, skill, and devotion to science of a class of men—theorists—who spent their lives in a tireless search after truth and in its demonstration. From the nature of things, chemistry is an experimental science. An experiment has been aptly defined as a question addressed to Nature. Chemistry demonstrated by just such inquiries the broad theorem that matter is indestructible. So grand a principle as this applied to all manner of substances—solid, liquid, and gaseous. But this principle demanded that the chemical action of one substance upon another should be accompanied by a change of state, in which the weight of the substance changed should remain unaltered. Therefore, the quantity of the substance changed could be accurately determined, because the existence of fixed laws governed every change. Quantitative analysis became a possibility. By it a substance in whatever state of change or combination could be identified, extracted, exactly weighed, and then resolved into its former condition without loss. Water could be split up into its component gases—hydrogen and oxygen. These gases could be separated, weighed, found to exist in the proportion of two parts of hydrogen to one part of oxygen, reunited, chemically combined by a spark, and then give precisely the same weight of water first taken, and possessing all of its original properties. All material substances, whether in the earth, the sea, or the air, could be isolated and their quantities determined with an unfailing accuracy. The proofs surround us. The products of a hundred industries; the forces at work in operating them—iron and copper; heat, power, and light. Indeed, in this our day we are aware that the truths of chemistry and its great principle, developed by means so simple as analysis, expand with the growth of knowledge, and extend from the earth to the limits of the celestial system. Certain of the elements so far found in the earth have been discovered in the sun, and even in the remote planets. How much do we owe to this mistress of our civilisation—the benefactress of art, philosophy, and religion?

The elements for which we are thus indebted to the researches of chemistry are accordingly the total number of separate indivisible substances found to have entered into the composition of every known body. A compound body may consist of only two elements, as water, for instance, or it may contain more, as sugar, composed of three elements, hydrogen, oxygen, and the third, carbon, or limestone, oxygen, carbon, and calcium. Consider that the same principle of chemical constituency holds good for every material body in the organic or inorganic kingdoms. Sugar can be artificially made. Limestone is found to be a proportionate relation of oxygen, carbon and calcium. These elements, then, brought together in the same association produce limestone, or calcium carbonate, which artificial product has properties similar to the naturally-occurring substance. The list of elements which concerns the limits of this discussion is as follows:—Iron, carbon, silicon, phosphorus, manganese, sulphur, aluminium, arsenic, titanium, copper, calcium, magnesium, and allusion will be made to a few of the more rarely occurring elements—nickel, chromium, tungsten, vanadium and uranium.

(To be continued.)

* An address by Clemens Jones to the Foundrymen's Association of Philadelphia.

Shipbuilding Notes.

Messrs. Scott and Co., Greenock, have contracted to build and engine a steel screw steamer of 1250 tons register for Messrs. J. and J. Denholm, Greenock.

It is stated that Messrs. Harland and Wolff have received an order from the White Star Line to build a new steamer 800ft. long for the Atlantic passenger traffic. The firm is at present hastening the completion of the new White Star liner "Gothic," which is about 500ft. long and 8000 tons, and is expected to equal the "Campania" in speed.

The screw steamer "Cumberland," recently launched by Messrs. John Fullerton and Co., Paisley, and built to the order of Messrs. James J. Mack and Sons, Liverpool, went down the river on the 4th inst. on her trial trip. Proceeding down the Firth, the measured mile at Skelmorlie was run, with and against the tide, at a mean speed of 10¾ knots.

The "Barham," third-class cruiser, and the "Galatea," belted cruiser of the first class, made commissioned trials of their machinery at Portsmouth on the 12th inst. The former, with 136lb. of steam, 174 revolutions, and a mean air pressure of 1·15in., developed 3311H.P., and attained a log speed of 16·2 knots; while the latter, with 129·7lb. of steam, 98·5 revolutions, and an average air pressure of 0·2in., indicated 6305H.P. and realised a speed on the measured mile of 16·925 knots.

The first-class protected cruiser "Endymion," 7350 tons, which was recently received at Portsmouth from Earle's Shipbuilding Company, Hull, has made the official eight hours' trial of her machinery. The mean draught of the vessel was 20ft. 7in., or 3ft, 2in. less than her load immersion; and, with 152lb. of steam pressure and 99½ revolutions, the starboard engine indicated 5261 and the port engine 5385, giving a collective power of 10,646H.P., with a mean air pressure of 17in. The average vacuum was 27in., and the speed of the ship by log 20·9 knots.

On the 6th inst., the screw steamer "Holmside," which has been built by Messrs. Wood, Skinner and Co., Bill Quay, went for her official loaded trial trip off the mouth of the Tyne. The trial was in every way successful, giving entire satisfaction to all concerned, as although a strong easterly wind was blowing a speed of over 10½ knots was obtained. The triple-expansion engines have been constructed by the North-Eastern Marine Engineering Company, Wallsend, and have cylinders 17in., 28in., and 46in. diameter, by 30in. stroke. Her principal dimensions are:—Length between perpendiculars, 206ft.; breadth, extreme, 30ft.; depth moulded, 16ft.; and a carrying capacity of about 1300 tons.

The Study of Electrical Engineering.

A CONTEMPORARY has lately been devoting some space to the much-discussed, but still vexed question of the course to be pursued by aspirants desirous of meriting the title of electrical engineer. Good service can be done on their behalf, and on that of the profession, by permitting those willing and competent to express their opinions to put forward what they consider to be the main channel, with the shoals, quicksands, and rocks which lie on and around the track of beginners. The most difficult thing for the lad choosing a calling is to know not so much which to decide upon, as to obtain reliable information upon which he would himself, or his relatives for him, make a selection.

The important feature, in the present instance, is the publication of the opinions of those who are themselves large employers of labour. Of this labour a considerable percentage is of the class whose training is under discussion. A simple answer to the question would therefore be:—The best and most suitable training for positions included in the calling of an electrical engineer is that which meets the views of likely firms — possible employers,— and therefore renders the embryo electrical engineer favourable in the sight of those who alone can place him in positions of the kind he seeks.

It is interesting to average what such opinion is, for professors and training colleges must clearly, to produce a marketable article, model their manufacturing processes so as to meet the average views of those requiring, or who may require, the services of such as have been trained or primed with scientific or technical lore. We must dissent strongly from the view put forward by one of the writers in the columns of our contemporary when he suggests that electrical knowledge is what salaries are paid for. Further, the distinction he draws between an "apprentice" and an "articled pupil" is not likely to find favour with those who have passed "the third degree" in the electrical industry. Only the slightest importance is attached to such a distinction, which is of value not in itself, but in what it represents, as will be pointed out presently.

Let us suppose two lads of fifteen or sixteen years of age enter the shops of a well-to-do firm engaged in mechanical, electrical, contracting, and manufacturing work, the one the son of a better-class mechanic or artisan, and the other that of a professional or business man having an income of, say, £1000 a year. Wherein will the position of the two lads differ? It may fairly be taken that nowadays a few pence a week will enable one to obtain as good an education as can be bought at any price for lads at such an age. Under these circumstances the chances of the two seem but proportional to their abilities. In other words, they are both "scratched" in their start for the prizes to be gained in the race of life. During their apprenticeship it is a case of neck-and-neck run; neither need have a decided lead. So the years pass away, and they emerge from their probation to seek fortune's smiles as equally well qualified electrical engineers. Now, at this point something wonderful happens. The one is seen to take up an appointment as assistant engineer to some company, lighting station, or corporation, while the other is compelled to become a journeyman, or starve. This is the point so often lost sight of in discussing the question at the head of this article. The all-important factor is *not* the exact course of training, *but* given a fair training and a receptive head on the shoulders of the beginner, what influence can be brought to bear in obtaining for him a preference over the host of other applicants for every vacancy on the "staff." This is the one thing which lifts one of the twain to the position of a young engineer—a professional man—a representative of the masters' interests, and leaves the other but the dry bread of a weekly wage and a trade. The premium pupil gains one thing by his ability to pay what are usually large sums to his firm: and that one thing is, he establishes his individuality from the first. He is Mr. So-and-so; incidentally he is given the run of the shops, the entrance to the drawing office is open to him, and if he be at all anxious to make use of his opportunities, the commercial and "cost" knowledge he can gain in this way would be worth far more than the premium which had to be laid down to enable him to obtain it. This may all appear very hard, and even be considered an undue forcing of class privileges, but will anyone with a knowledge of the facts attempt to deny it? Over and over again this feature in the training of men in the various branches of engineering industry has been shown to be *the* one—not merely, be it noted, a help to the favoured patrician, but by its presence or absence deciding the fate of each one as he emerges from the training period. Of course there are exceptions—without them there would be no rule; but recent action on the part of a certain institute has exemplified the truth of the foregoing in a startling manner. The man with a few hundred pounds at his disposal may, with reasonable attention to his own interests, become an electrical engineer at a salary at least superior to a first-class workman, be on the staff and be considered a gentleman, with every prospect before him of a respectable and comfortable life. Without such a capital or its equivalent of friends in high places, another and more brilliant individual remains No. *n*th on the time-sheet, and by the force of circumstances hemming him in on every side he is restrained from even reaching the bottom rung of the ladder, higher up on which he sees old shop comrades and those who in former days were "Hail fellow, well met" with him.

To return to the course of training best suited to enable one possessed of the advantages enumerated to utilise them to the full for his own benefit and that of his coming employers, the fact cannot be pressed home too closely that in central stations, electric traction operations, and still more during the manufacture of plant, the leading requirement is a good, sound mechanical training.

This does not necessarily imply a deep study of the steam engine, or a tedious spell in a mechanical engineer's works; but it does enforce having spent at least some years in the operations incidental to the creation and repair of the appliances over which, at a later date, the pupil or apprentice hopes to exercise control. The craftsmanship displayed by the aspirant at the end of his shop training need not be of a very high order, provided that it is such that he could earn his livelihood, if ever necessary, by its use. The knowledge in each department through whose portals he has passed should be as sound and thorough as by his own efforts and the facilities for gaining experience permit. This will vary with different works and firms, and even with a single firm at different periods of its career; but if a modicum of care be taken in the first place, the finished product will possess a commercial value, and it is this alone which will stamp the course pursued in the meantime as being a suitable and satisfactory one.

The subject is one which has an interest at all times during the continuance of the industry, and it has been treated in many ways, with different objects, and by the pens of some of the most eminent men in the profession; still the ball rolls on. Now and then it gets a kick one way or the other, but all the while colleges scoop in fees of one hundred guineas per head per annum by the score; works their dozens of premiums, some higher, some lower, than this; and the cry of electricity in its infancy brings still further crowds to fatten upon its sinecures.

Sinecures are not always forthcoming; but in other cases the fattening process proceeds without visible result—now and then the result requiring a minus sign before it to express the value correctly.

The utterances of speakers and writers on a question of present-day interest is, like the times in which they live, apt to be flavoured with self aggrandisement and advancement; and, on a matter of training, the views put forth by individuals are those most conducive to their own ends. It would be well for would-be dabblers in electro-technics to ascertain their chances of obtaining their share of the "common lot it is our duty to perform," for, with all the will in the world, others before them have found it hard to obtain. Should they then determine to embark in the calling, they would be well advised were they to go in for mechanical training thoroughly, obtaining a proficiency in drawing-office work, and superimposing upon such a reliable foundation the knowledge of thermo-dynamics (theory of heat and operation of steam in the steam engine), chemistry, mechanics, and theory of electro-dynamics which, with some practice in electric measurement, can easily be obtained in any of our large towns by evening classes or private study, supplemented, if desirable, by a year's course after leaving the works.

This, says the "Electrical Review," we believe to be not only the best course, from the advantage to be gained by such as follow it, but also that most likely to give the beginner a wide field to choose from when he comes to start as a wage-earner or salaried officer upon special work.

By all means let him become a specialist; but the time for this is after, not before, his entrance upon the sphere of practical work. High achievements and the flights which lead to success are almost always of the specialist kind; but were one to do so at an early stage the tendency would be overpowering to drop into a groove, and by limiting one's greatest attention to one subject, by concentrating the best of one's energies upon it lose sight of the rest of the field before knowing the general configuration of the country, and the nature of surrounding lands.

Notices of New Books.

THE ENGINEER'S POCKET-BOOK. Prepared by the Technical Society, "Hütte," of the Royal Technical High School at Berlin, Germany. Fifteenth edition, revised and enlarged. Berlin: Wilhelm Ernst and Son. 1892. 9 marks.

SINCE its first appearance in 1858 this pocket-book—originally compiled by a committee of the Students' Society, "Hütte," at the Technical School at Berlin, from their notes of the lectures delivered to them, and other sources, chiefly for their own use—has passed through fifteen editions, which sufficiently testifies to its merits. Each successive edition has been enlarged and brought up to date in the various parts of the work, so that from a tolerably moderate size it has grown into a voluminous work of over 1500 pages, and may be more correctly designated as a compendium of mathematical and engineering formulæ and information, than as a pocket-book in the usual meaning of the word. It has been compiled with characteristic German thoroughness, and its success shows that it meets a demand amongst German engineers. In preparing the new edition—which comprises nine sheets more than the fourteenth—the society has been fortunate enough to enlist the co-operation of a large number of practical engineers and professors at various technical schools for revising and rewriting several parts, amongst them Professors C. Bach, A. Ernst, G. Hermann, J. Hrabach, W. Kohlrausch, H. Müller-Brislau, A. Riedler, and others who are well known by their works on various branches of mechanics and engineering, so that although the committee of the society had the general arrangement and editing of the work, it is really the production of a large number of specialists and men eminent in theory and practice.

The work is made up of two main parts, divided into seven and nine sections respectively, each containing several chapters. The first section—mathematics—has been increased by a graphic method of solving algebraic equations and formulæ and tables on hyperbolic functions, while the tables of contents of surfaces and bodies have been rearranged, and a table of contents of spheres recalculated. The chapter on parallel perspective has been enlarged. In the second section—mechanics—the chapters on motion, statics, and dynamics of rigid bodies have been entirely re-arranged; that on the properties of gas and steam enlarged by the results of recent experiments in connection with compressed-air plants. Similar overhauling has taken place in the remaining sections of this part—viz., heat, strength and elasticity, machine details, labour machines, and motors. Amongst the details several additions have been made, tables on gear wheels, pulleys, chains, etc., the chapter on governors being rewritten; the labour machines have been enlarged in the formulæ and cuts relating to cranes. In the section on motors, the valve motions for steam engines have been thoroughly overhauled and enlarged. Amongst the matter relating to boilers, the new Acts relating thereto in Prussia and Austria have been added. When we state that over 150 pages of the pocket-book are devoted to steam engines and boilers our readers will be able to form a good idea of the exhaustive way in which the different subjects have been treated.

The second part contains sections on surveying (description and use of instruments); railway construction (permanent way and rolling stock), which has been revised according to the latest Prussian rules; bridge and girder construction; building construction, in which the chapters on heating and ventilation have been overhauled and enlarged. These are followed by a section on shipbuilding, including engines and propellers, to which numerous additions have been made, Barnaby's calculation of ship propellers being one of them. The next section, on iron manufacture, might, we think, be advantageously omitted in subsequent editions — except a few notes on rolling mills—as being not of much importance to engineers generally, so as to lighten the volume, or make room for additions in other chapters. The section on mechanical technology is to a great extent subject to the same remark. The specialist in the different branches possesses more complete and extensive guides, while the general mechanical engineer not engaged in them would not derive sufficient information from the necessarily condensed notes on the various machines. Some general information as to the speeds of shafting and power required for driving the machines, and their production, would, in our opinion, suffice for the general engineer, the construction of the machines themselves being a matter of practically acquired knowledge. The chapter on gas manufacture contains matter that is more generally useful, and most of it would be acceptable to engineers generally. The next section, on electro-technics, has been enlarged by additional notes on accumulators, transmission and distribution of power. The whole, as we have remarked, forms a concise compendium of mathematics and theoretical and applied mechanics in the fullest sense, and many chapters are models of concise and yet clear treatment of extensive fields of knowledge.

The volume concludes with a section on materials in which the different tables of weights and strengths of metals, wood, and stone—dispersed through the text in previous editions—have been collected, to which an appendix on weights and measures of different countries, with conversion multipliers, the German Patent law, customary fees for engineers and architects, have been added. The work forms a most useful book of reference for any engineer acquainted with the German language.

Trade Notes.

The Cail Works, Paris, have obtained an order for 25 locomotive boilers from the Orleans Railway Company.

Messrs. J. and S. Roberts Limited, West Bromwich, have obtained a large contract for cast-iron pipes from the Cardiff Corporation.

Messrs. Rushton and Co., of Prague, have recently constructed a large bridge over the river Radotinka. All the iron work is composed of Mannesmann seamless tubes.

Messrs. Felten and Guilleaume, of Mulheim-on-the-Rhine, have purchased the cable works belonging to Mr. T. Obach, of Vienna, and intend to extend the business.

Messrs. Charles Brand and Son, Glasgow, have been instructed by the Scotch Office to proceed with the construction of a harbour and breakwater at Port Ness. The cost is estimated to be about £30,000.

Messrs. Davey, Paxman and Co., of Colchester, have received an order, amounting to £2900, for the supply of engines and machinery for the pumping station of the Chertsey Rural Sanitary Authority.

The American Screw Company, Leeds, following Messrs. Nettlefold's example, have increased their discounts by 10 per cent., making them 67½ per cent. Thus the American Company, like the Birmingham firm, have reduced net prices 21 per cent.

The directors of Messrs. G. Kynoch and Co., Birmingham, have resolved, subject to the final audit of the accounts for the twelve months to March 31, 1893, to recommend the payment of a dividend at the rate of 10 per cent. per annum on the preference shares for the twelve months to that date.

Messrs. Crosier, Mills and Co. are removing their offices from 9, Queen-street to 58, Collingwood-street, Newcastle-on-Tyne, where they will have a showroom for the display of machine tools, Mills' boat gear, cromil bronzes, and other engineering specialities.

Messrs. W. Baird and Co. Limited, of Glasgow, have secured by purchase from the Pedroso proprietors the celebrated iron mines in the province of Seville, known as the Monte de Hierro and others. These mines are very extensive, and are capable of yielding for many years to come large quantities of the finest ore for making hematite pig iron.

We understand that the works and patents of the Shaw Engineering Company Limited, Ashton-gate, Bristol, have been purchased by Mr. W. H. Lindsay, and a new company formed, who will carry on the business under the style of the Coil Clutch and Pulley Company Limited. Mr. J. M. Harvey, Queen's Chambers, John Dalton-street, Manchester, will continue to represent the new firm in this district.

On Testing Machinery and Electric Water-level Recording Apparatus.

(*Concluded from page* 182).

Electric Water-level Indicator and Recorder.—The instruments shown in Fig. 9 are designed to record the fluctuations of water level in a reservoir at a distance, and consist (1) of transmitting instrument placed at reservoir, and acted upon by a float, (2) of receiving instrument with dial, clock, and drum, placed in engine room or engineer's office, which may be miles from reservoir. The connection between the two instruments is by a single line wire, carried on poles, or laid underground, as may be found most convenient.

Transmitter.—On one of the pulleys on horizontal shaft a phosphor-bronze cord is wound, carrying a float, which rises and falls with the water level. On the other pulley a balance weight is suspended to take up the slack of the cord when float is rising. Motion is thus communicated by means of toothed-wheel gearing of brass to the tumbling arm, which arm makes one revolution for each 1in., or 2in., or 3in., as the case may be, of rise or fall of float. In falling over, after it has passed its upper centre of gravity, this arm acts upon one or other of the two side levers shown, thus making an electrical contact—to the left side for a rise, and to the right side for a fall. The weight on this tumbling arm consists of a light, short steel tube, sealed and at right angles to the arm, and containing mercury to about three-fourths of its capacity. This ensures that whenever the weight passes the centre it falls over on account of the mercury flowing to the lower end of the tube. The fall is retarded to some extent by a fly which is geared to the axis of the falling arm so as to give sufficient time to make a good electrical contact. The contacts, which are in duplicate, are of platinum, and have a rubbing or sliding motion to ensure their being kept clean. The moving parts are on dead centres to secure least friction. A battery of three or four cells is placed at reservoir, connected up as shown on drawing.

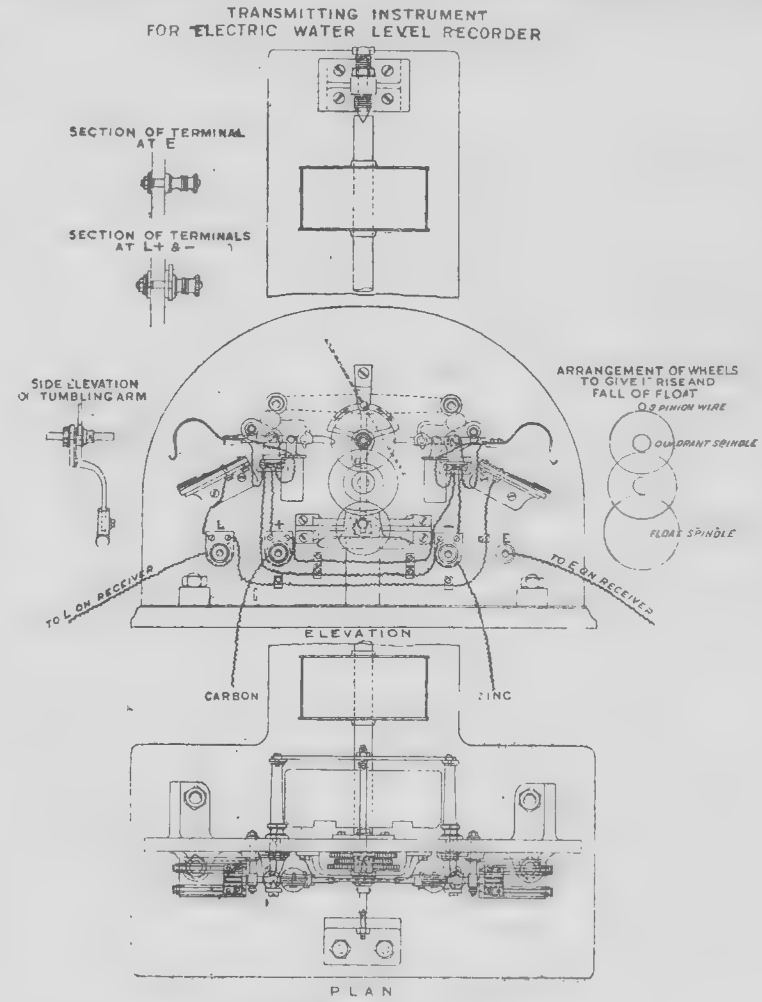
Receiving Instrument (Fig. 10).—The current from the reservoir is by means of relay and local battery of two or three cells made to act upon one or other (according to rise or fall—positive or negative) of the two pairs of magnetic coils, attracting one of the pendulous arms, which are hung on dead centres, and each of which carries a keeper. When the arm is pulled over by the magnetic coil, the pinion on main shaft is made to revolve to the extent of one tooth, and only one, as, when pulled over, a locking bar prevents any further movement. When current is released, the pendulous arm swings back by gravity to its normal position. A detent, acting by a light spring or roller, on a pinion with rounded teeth, prevents vibration from causing any movement of the shaft or index pointer. The coils themselves, as well as the pawls on the arms, are adjustable. A wheel geared to main shaft carries an index pointer on its shaft, indicating water level on dial.

Vertical motion is given to the pen marking on diagram by a light wire cord having a turn and a half round pulley on main shaft. The drum carrying diagram makes one revolution in 24 hours, or in one week, as may be desired. The diagram on the clock drum shown on instrument (see Fig. 9) is a 24-hour one, and is from Rochester Waterworks, near Chatham. The other diagram, shown separately below (Fig. 12), is from East London Waterworks—it gives one week's record. A set of instruments recently sent out to New Zealand had an electric alarm bell to warn the engineman when reservoir was full and empty.

The set of instruments at the works keeps a record in the office of the water level in elevated cistern, to which water is pumped from the river for testing purposes, and which is situated near the northern extremity of the works.

A reliable indicator and recorder is a valuable adjunct to a waterworks, especially in pumping schemes, as pumping to overflow causes great loss and waste of water, and the record of water level is most valuable for reference as much in the interests of the engineer as the engineman and the public.

A set of these instruments is exhibited so that the members may better understand their action.



TESTING MACHINERY, ETC.—FIG. 11.

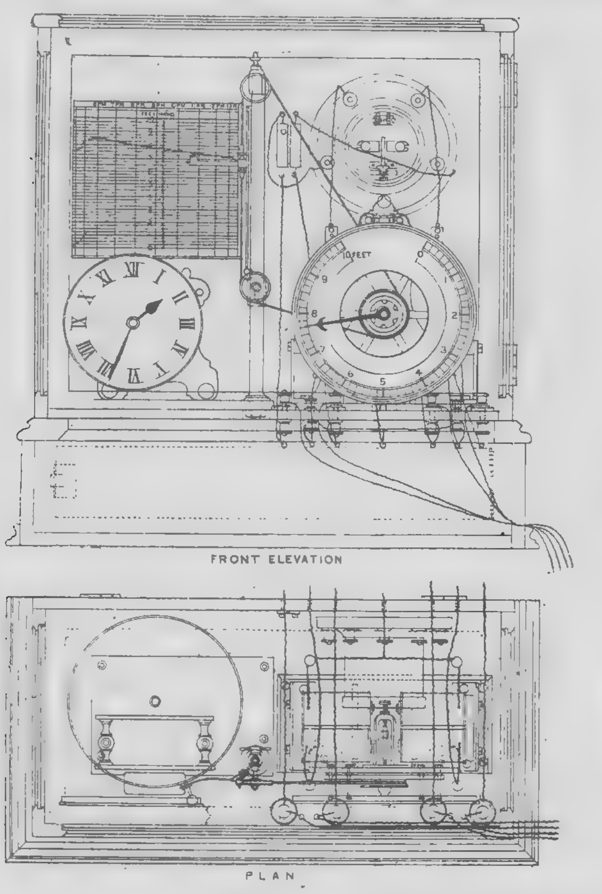


FIG. 9. TESTING MACHINERY, ETC.

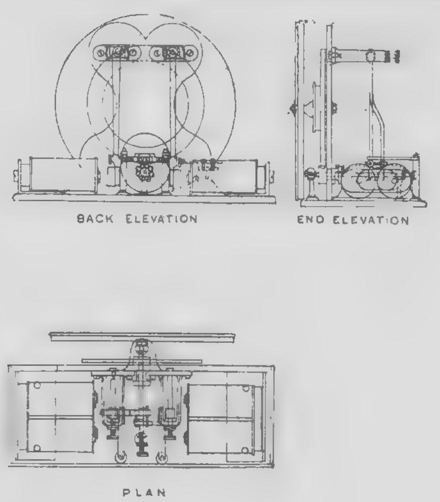
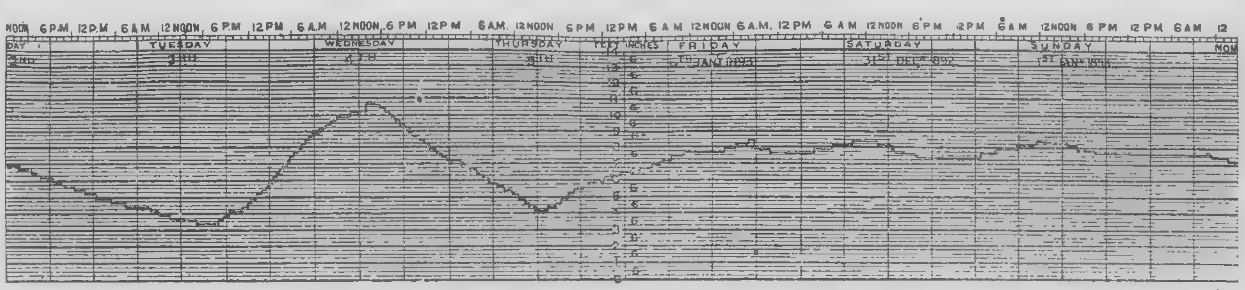


FIG. 10.



TESTING MACHINERY, ETC.—FIG. 12.

On Belting for Machinery.

(*Concluded from page* 144.)

IT is better to sacrifice initial strength of the belt than any of these other qualities, and the first two of these qualities are not to be sacrificed for any of the others, which are placed as nearly as possible in the order of their importance.

A consideration of these requirements will show why plain single leather belting has held its own for the great majority of cases of belt transmission.

Its weak point is that it is easily altered in its most essential properties by damp and heat, so that other materials have to take its place where the belts have to be subjected to such conditions. The same general requirements, however, remain to guide us in our selection.

The most experienced makers of leather belting have fully grasped those requirements, and select those portions of the hide which most fully meet the first three of them. Those portions are not the strongest or toughest or softest portions.

It will now be clear that, after all has been said that there is to say on the theoretical considerations as to friction factor, angle of contact, working strain, ultimate strength of the belt, etc., the most important elements in the question can only be decided by experience. We therefore now proceed to determine by this method what a good belt may be expected to do under a given set of circumstances, taking with us the approximate information obtained from preliminary investigations to enable us to predict qualitatively what will be the result of a variation in the circumstances.

I have found that a single leather belt meeting the conditions enumerated will work for years at full load with so little stretch that it only requires taking up about once a year if it is worked according to the rule given by Messrs. Hoyt and Co. and some other first-class makers—viz., "1H.P. per inch at 1000ft. per minute.'

Referring now to our approximate ormulæ, we find that this gives the following values for the working conditions of a single belt 1in. wide, running at 1000ft. per minute, and embracing half the circumference of the pulleys.

$$R = 33\text{lb.} = T_1 - T_2.$$

$$\log.\ \frac{T_1}{T_2} = 2{\cdot}7288\ f\ n = 2{\cdot}7288 \times 0{\cdot}15 \times 0{\cdot}5 = 0{\cdot}20466.$$

$$\therefore \frac{T_1}{T_2} = e^{f\theta} = 1{\cdot}602.$$

$$\frac{T_1 + T_2}{2\,R} = \frac{1{\cdot}6 + 1}{2\,(1{\cdot}\dot{6} - 1)} = 2{\cdot}1\dot{6}.$$

$$T_1 + T_2 = 2 \times 33 \times 2{\cdot}1\dot{6} = 142.$$

$$T_1 - T_2 = 33.$$

$$\therefore 2\,T_1 = 175.$$

$$T_1 = 87{\cdot}5.$$

$$T_2 = 54{\cdot}5.$$

Or a working strain on the driving side of 87·5lb. per inch width.

This, then, may be taken as the probable maximum working strain, calculated from the results of actual experience of the

lasting power of the belt, and it may again be remarked that this bears no direct relation to the breaking strain—which is for the solid part of the belt 1040lb., and for the cemented joint 842lb. per inch in width. It is much higher than the strain usually stated to be the working strain, because it is arrived at by deduction from an assumed ratio of the working tensions based on a friction factor much lower, and therefore surer for calculation, than the figure usually adopted.

Of course I do not suggest that these tensions are to be put on the belt, but only that allowance should be made for the tension reaching this amount. For double belts it is usual to calculate that they will stand 1¾ time the working strain of a single belt.

It will now be seen how the preliminary conditions may be varied so as to vary the power transmissible by any given belt, assuming the friction factor as a constant. We can vary the arc of contact and the speed of running, and it of course follows that the greater the arc of contact and the higher the speed the more power may be transmitted by any given belt.

It should be borne in mind that to get satisfactory results from belt-drive it is not best to leave the whole question to be settled by the belt. The pulleys should be designed so as to give the belt the best chance possible to do its work.

They should be large in diameter, because this gives high belt speed and increases the efficiency; 3000ft. per minute is an easy speed for leather belts. They will run well at a speed of a mile a minute.

They should be so placed and arranged that the arc of contact with the belt is as large as possible, because the ratio between the tensions approaches unity and their sum, and therefore the maximum strain on the belt is smaller the larger the arc of contact.

They should be flat, not crowned, because crowning the pulley transversely strains the belt, and a good belt will run well without any necessity for this strain.

They should not be flanged, because the flanges damage the edges of the belt and introduce useless friction, owing to different speeds at different diameters of the flange which may touch the belt as it enters or leaves the pulley.

They should not be too far apart, because a belt does not transmit its working strain direct to the pulley when it is so long as to set up a swinging lateral motion.

They should be turned smooth on the face, because a rough pulley tears the surface of the belt and produces destructive wear.

They should be truly centred and balanced, because irregular motion of the pulley produces irregular strains in the belt which may exceed the regular proper working strain.

They may with advantage be covered with leather, because the friction between leather and leather is greater than between leather and iron, and the belt will run with less tension on pulleys so treated.

They should be placed with their centres as nearly horizontal as convenient, because vertical belts tend to sag off the lower pulley.

They should be lined up truly parallel for simple drives, because if they are out of truth one edge of the belt will get most of the work to do.

Wherever possible the slack or driven side of the belt should run uppermost, because the sagging slack upper side tends to increase the arc of contact with the pulley.

We may now devote a few words to the treatment of a belt when at work. I have not found it necessary to use anything at all in a good leather belt. A little castor oil, or the heavy mineral oil known as "Post" oil, helps to keep the belt flexible in a warm place.

Rosin, dubbin, and all sticky substances are fatal to belts. They rapidly destroy the surface of the belt and waste power by sticking it to the pulley. By accumulating in lumps or ridges on the surface of the pulley, they also strain the substance of the belt and lead to its destruction.

Single leather belts should not be used with belt forks to pass from an idle to a working pulley unless they can be run very slack, because otherwise they rapidly become twisted by unequal strain and give way by tearing. The best belts for this purpose are belts which are of a built structure, and run edgewise to the pulley.

All belts should be put on in the first instance by skilled workmen. As has been pointed out, the best belts are not those which will stand the greatest strain, and the best joints are not those which can be made by unskilled hands and rough-and-ready methods.

New belts are often put on too tight under the mistaken notion that allowance must be made for a great amount of stretching. A good belt will break with a stretch of only 3 per cent. A bad one may go on stretching indefinitely. A good belt put on askew is a good belt wasted. Too tight a belt wastes power in journal friction. Too slack a belt is apt to slip and waste power by rubbing the pulley. It is also liable to come off the pulleys altogether.

The proper tension at which to put on a belt may be roughly stated to be that at which the belt when standing feels yielding, but firm and springy to the hand. If it feels like a drum head it is too tight. If it feels like a rein for driving a horse it is too slack.

If these latter remarks have a pedagoguic ring about them it is due to an effort to compress them into as little space as possible, because I do not consider my opinions of sufficient authority to take up time by stating them at greater length, and I feel that I need to offer an apology for undertaking to bring before you a subject which, after all, I know very little about.

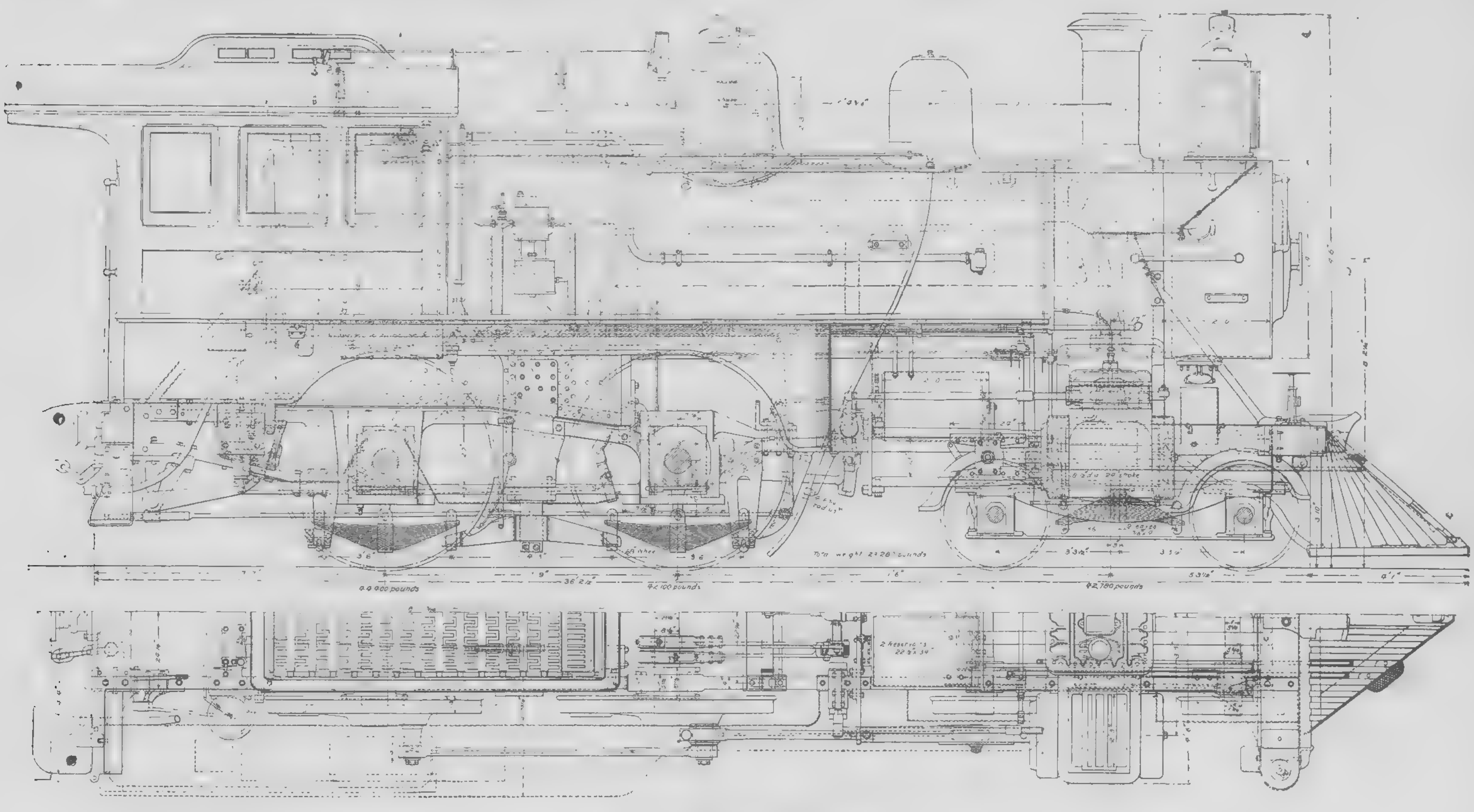
For information on this subject I am much indebted to my friend Mr. Balderston, of Messrs. Hoyt and Co., now Fayerweather and Ladew; also to Messrs. Tullis and Co., and others, who have kindly supplied me with samples for experiment.

I am also indebted to Mr. Carey and to the Steel Company of Scotland for facilities for making tests of tensile strength.

An American Passenger Locomotive.

THE illustration herewith shows a passenger locomotive built at the Schenectady Locomotive Works, for the Chicago, Cleveland, Cincinnati and St. Louis Railway. The principal general dimensions are given in the following table:—

Gauge	4ft. 8½ins.
Cylinders	18½ins. diam. by 24ins. stroke.
Driving wheels, diam.	68ins.
Wheel base, rigid	7ft. 9ins.
" " total	22ft. 8½ins.
Weight, on drivers	86,500lb.
" " bogie	42,780lb.
" " total	129,280lb.
Tubes, outside diam.	2ins.
" number	241.
Tubes, length between tube sheets	11ft. 4ins.
Tubes, thickness	No. 10 B.W.G.
Heating surface, firebox	143·74 sq. ft.
" " tubes	1426·28 sq. ft.
" " total	1570·02 sq. ft.
Grate surface	31·3 sq. ft.
Boiler pressure	180lb. per sq. in.
Exhaust nozzle, diam.	4½ins.
Valve travel	5⅝ins.
Valve outside lap	$1\frac{1}{16}$in.
" inside lap	0.
" lead	$\frac{1}{32}$in.
Throw of eccentric	2¾ins.
Steam ports, length	23ins.
" " width	1¼in.
Exhaust port, length	23ins.
" " width	2½ins.
Boiler diam., maximum	60ins.
" " minimum	58ins.
Journals, driving	8½ins. diam., 10½ins. long.
" engine truck	5¾ins. diam., 10ins. long.
" tender truck	4¼ins. diam., 8ins. long.
Tank, capacity	4000gals.
Coalbox, capacity	7 tons.
Weight of tender, loaded	85,280lb.



AN AMERICAN PASSENGER LOCOMOTIVE.

As will be seen from the cut, the frame is offset downward back of the forward driving box to allow a deeper firebox than could otherwise be used. The frame is also thickened at the jaws, being 5½ins. at these places and 4ins. at all others. This is to give greater wearing surface for the wedges. The journals are large, 8½ins. × 10½ins.; and, in fact, all the wearing surfaces have liberal dimensions, and are in accordance with the best modern practice.

The design of crosshead is a departure from ordinary practice, as the outside wings are bolted to the crosshead, so that when lining up it is only necessary to remove the eight nuts, slip off the wings and insert the liners.

The steam ports are 23ins. long and the valve travel 5⅝ins. These long ports are designed to improve the steam admission. The link is 3ins. wide, thus giving liberal wearing surface to correspond with other parts. The valve gear was designed to give a constant lead at all points of cut-off; how nearly this was obtained is shown in the following table:—

Cut-off.		Valve Opens.		Lead.	
Front Stroke.	Back Stroke.	Front Stroke.	Back Stroke.	Front Stroke.	Back Stroke.
19¾	20	1⅝	1⅝	$\frac{1}{16}$	$\frac{1}{16}$
18	$18\frac{5}{16}$	1¼	$1\frac{7}{32}$	$\frac{3}{32}$	$\frac{3}{32}$
16	$16\frac{5}{16}$	$\frac{29}{32}$	⅞	$\frac{5}{32}$	$\frac{5}{32}$
14	14⅛	¾	$\frac{23}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
12	12	$\frac{19}{32}$	$\frac{9}{16}$	$\frac{3}{16}$	$\frac{3}{16}$
10	10	½	$\frac{15}{32}$	$\frac{3}{16}$	$\frac{3}{16}$
8	8	$\frac{13}{32}$	⅜	$\frac{3}{16}$	$\frac{5}{16}$

This nearly constant lead has been gained by setting the back gear eccentric so that there is a negative lead in back gear—that is, the back motion has no lead, and in fact the valve does not open until the crank has passed the dead centre.

On Machine Designing.

[CONTRIBUTED.]

(*Continued from page 188.*)

(10.) SAFETY DEVICES.—Such are the governor of a steam engine, for preventing excessive speed of rotation; the safety valve of a steam boiler, for preventing excessive accumulation of pressure; the safety catches of suspended hoists, for preventing rapid descent when the chain breaks; buffers, to deaden the concussion between two colliding bodies; and automatic depression-controlling gear, for preventing the heavy guns of battleships being fired in positions dangerous to the superstructure of the ship.

(11.) SIMPLICITY.—The more simple a machine is the less the probability of its derangement, and, if efficient, the more perfect mechanically. Hence this quality must always be aimed at, and proposed arrangements carefully examined with the view of seeing whether any simplification is attainable. Investigation often reveals a more simple way. Compare, for example, the complexity of the valve gear of old steam hammers, with the simplicity of modern gears for effecting precisely the same purpose.

(12.) DURABILITY AND ACCURACY.—The durability of a machine, assuming ample strength and stiffness of the parts, depends on the nature and extent of its bearing surfaces, on the degree of efficiency of its lubricating arrangements, and on the care taken in the provision of adjustments to compensate for wear—all of which matters are determined by the designer. For the sake of durability every nut which requires to be frequently slacked off and tightened up again should be casehardened to prevent mutilation by the spanner.

In arrangements involving the use of wheel gearing, accuracy of shape of the teeth has much influence in determining the life and easy working of the machine. This matter, therefore, should receive the designer's careful attention.

The accuracy of machines depends on the truth of the surfaces and the quality of the workmanship generally—matters which fall somewhat without the province of the designer.

(13.) STABILITY.—The conditions of stability are: Sufficient weight and rigidity of framing, to prevent vibration; ample area of base, so that the foot of the vertical through the centre of gravity of the machine may fall well within the base; a substantial foundation, and efficient holding-down bolts. The proper balancing of moving parts also much conduces to stability. All fly-wheels, pulleys, and revolving parts generally, should be adjusted so that the centre of gravity of the mass coincides with the axis of rotation. Reciprocating parts should be balanced wherever practicable—as, for example, the ram of a slotting machine, the cage of a hoist, a system of rods, levers and connecting rods. This prevents waste of energy, and conduces to smoothness of working. Some vertical high-speed marine engines have had the reciprocating part completely balanced by "bob weights," which move up and down as the piston, rods, etc., move down and up. The result is a great diminution of vibration. Locomotives usually have the reciprocating parts partially balanced.

(14.) ANTI-FRICTION DEVICES. — It is manifestly desirable that machinery should run with a minimum loss of energy through frictional resistances. In some cases it is indeed essential. Hence anti-friction gears are often applied—as, for example, the ball bearings of bicycles, which furnish a means of converting sliding into rolling friction. Heavy weights rotate on a ring of live rollers. The hooks of heavy cranes, the turntables of swing bridges, the turrets of battleships, and the central pivot footsteps of gun carriages, are instances.

Knife-edges are also used in machinery to diminish friction, especially in connection with testing machines. These so-called knife-edges are commonly of hardened steel, the angle between the faces being about 100° and the sharp edge slightly rounded off. Thus the moment of the frictional resistance becomes very small. An ingenious system of anti-friction gear based on this principle has been applied, with very gratifying results, to the trunnions of heavy guns, the object being to reduce the power required for elevating the gun.

RECAPITULATION.

Thus we have seen that the qualities conducive to mechanical excellence are:—

(1.) Sufficient power.
(2.) Ample strength.
(3.) Suitable materials.
(4.) A good arrangement.
(5.) Generous bearing surfaces.
(6.) Efficient means of lubrication.
(7.) Adequate adjustment.
(8.) Correct indicating gears.
(9.) Lightness.
(10.) Reliable safety devices.
(11.) Simplicity.
(12.) Durability and accuracy.
(13.) Stability.
(14.) Effective anti-friction devices.

(To be continued.)

State of the Skilled Labour Market.

THE following memorandum has been communicated to the "Board of Trade Journal" by the Labour Department of the Board of Trade:—

Returns of unemployed members at the close of April have been received from 23 trade unions with a total membership of 296,771, of which number 20,478, or 6·9 per cent., are reported as being out of work, against 25,622, or 8·7 per cent., in the previous month. The figures, however, for this month are still 1 per cent. higher than for the corresponding month of 1892. They can hardly be looked upon as indicating an upward movement of a lasting nature, but must rather be attributed to seasonal causes of a more or less fluctuating character.

Six of the 23 societies describe trade as "good," eight as "moderate," and nine as "bad."

Notwithstanding the settlement of the dispute in the cotton trade, a large number of spinners in the Oldham district are still unemployed, the proportion having risen from 12 per cent. in April, 1892, to 28 per cent. in April, 1893. On the other hand, in the Bolton district, which was much less severely affected by the cotton dispute, the percentage of unemployed has fallen from 2·25 in the former to 1·85 in the latter period. Speaking generally, the engineering trades show a slight improvement when compared with last month, though when compared with the corresponding period of last year they are in an unsatisfactory condition, especially in the case of the iron shipbuilding trades, in which the tendency is still a downward one. The building and furnishing trades, as might be anticipated at this season of the year, continue to improve, and are generally in a good condition, while the printing and kindred trades have somewhat improved in the metropolis, though a falling off is noticeable in the provinces and also in Ireland and Scotland.

Seventy-three new disputes have been reported during the month, the most important being the strike in connection with the dock and shipping industries in Hull, directly affecting about 10,000 men, which for some time threatened to spread to other ports. A general strike in the shipping industries has been averted, at least for the time, though local disturbances have taken place in the ports of London, Bristol, and elsewhere. Next in magnitude come three mining disputes affecting 1200, 1000, and 800 miners respectively. It will be seen that the number of new strikes noted —viz., 73—is somewhat large, being 14 in excess of last month, and eight more than for the like period of 1892. In 36 of these strikes, for which full particulars have been received, 16,954 workers were concerned. In many cases, however, the numbers interested were small, and the disputes themselves of but short duration. Of the total 73 disputes, 23 occurred in the building trades, 11 in the mining industry, nine in the shipbuilding industry, eight in the textile trades, seven in the clothing trades, six in connection with shipping and dock labour, five in the metal trades, and the remaining four in various other trades and industries. Several of the disputes in the building trades were within the metropolitan area, and arose from differences as to the enforcement of the agreement mutually entered into last year by the representatives of employers and workmen in those trades.

Leeds Association of Engineers.

AT the last ordinary meeting of this association Mr. Sydney H. Wells, A.M. Inst. C.E., of the Yorkshire College, read a paper on "The Mechanical Efficiency of Prime Movers." The results of experiments on the work lost in the frictional resistance of gearing and shafting in workshops and mills, and in the working of steam, gas and oil engines, were described; also the results of investigations made by Professor Thurston, of America, and others, in measuring the frictional loss in the separate working parts of engines, and the effect of speed and load upon the mechanical efficiency. The figures indicated that the friction of engines did not vary with increase of load, the lubrication being perfect and the bearings properly adjusted. On the other hand, it is well known that with badly-lubricated surfaces the frictional resistance increases with the load. Apart from the all-important question of lubrication, it would seem that the frictional loss in shafting is lessened by using stiff shafts with sufficient bearing to prevent springing. The paper was illustrated by diagrams and figures giving the highest mechanical efficiencies known to the author of different types of prime movers. It might, he said, be expected that gas and oil engines, owing to the absence of stuffing boxes and eccentric straps, would be the most efficient, but the tables did not bear this out. He suggested that the subject did not receive the attention it deserved, and claimed that much good would result if engineers would pay more attention to the mechanical efficiency of the parts they fit into machines, and to the securing of better work from the engines themselves, it being highly probable that the gain thereby would be greater than results from many of the efforts to increase thermal efficiency.

London Association of Foremen Engineers and Draughtsmen.

THE usual monthly meeting of this association was held in the Cannon-street Hotel on Saturday, the 6th inst., at 7 p.m., the president, Mr. W. T. Coates, occupying the chair. Eleven gentlemen engaged in the different branches of engineering were elected honorary and ordinary members of the association, and the usual financial and other business was transacted, after which a paper was read by past-president Mr. John E. Reid, on "Commercial Colour Printing." Mr. Reid referred to previous papers which had been read on different classes of printing machinery, gave a brief historical sketch of the development of printing machinery, and proceeded to deal more in detail with the system and machines employed for the production of common match-box and other labels in three and four colours. He stated that for this class of work three sorts of machines were employed, which, although specially designed and well suited for that particular work, were of little use for general printing. The first is a machine which prints from the reel in one or two colours as required, and cuts off, after printing, a sheet 30in. long. The second machine is similar to the first, but without the cutting cylinder and delivery tapes, as the paper as it comes through this machine after being printed is passed through a tank of hot boiled oil to make it waterproof. The last class of machines are quite different in design to the first two, being used for one, two, or three colours, but nearly always for two and three. They are not self-feeding from the reel, but have to be fed somewhat similarly to the ordinary single-cylinder printing machine. The first-mentioned machines print three colours at one operation, and the third machine prints the fourth, or "key," as it is called. As showing the advantage of the rotary process for this class of work, he mentioned that these machines only occupy a floor space of 8ft. by 6ft. 6in., and can be driven with ease by a 2½in. belt, whereas the ordinary single-cylinder two-colour machine occupies a floor space of about 19ft. by 7ft., and requires a 4in. belt to drive it, and the cost of printing is only about ½d. per 1000 labels. After printing, the sheets are piled on each other and kept in correct position by needles and cut by guillotine machines into separate labels or parcels of labels, and the efficiency of this department is such that the cost of cutting ordinary labels and laying them in parcels of 1000 each is only ¼d. per 1000.

Several members expressed their surprise at the low cost of production, which spoke well for the efficiency of the machinery. Mr. Powrie spoke in appreciative terms of Mr. Reid's efforts in perfecting this particular class of machine, and described the arrangement of other types of multi-colour printing machines, and a vote of thanks was given to Mr. Reid for his interesting and instructive paper.

Metal Trade Memoranda.

The large Kopparberg Mining and Iron Company, in Sweden, during the year 1892 produced 31,000 tons of iron and steel, against 37,000 tons the previous year.

A few days ago, the celebration of the hundred-thousandth charge was held at the Teplitz Rolling Mills, Austria. These works have been in existence for about 21 years.

The import of nickel ore from New Caledonia, which was first brought direct to Scotland seven years ago, has now greatly increased. During the month of April, 8297 tons were received, being an increase of 3933 tons over the imports of April 1891.

The Tharsis Sulphur and Copper Company have, it is stated, contracted with Messrs. Morrell Brothers and Co., of Cardiff, and with Mr. Hugh Hogarth, of Glasgow and Ardrossan, to ship to Glasgow (during three years) about 60,000 tons of copper ore per year from Huelva.

The Consett Iron Company have succeeded in passing through their rolling mills steel plates of the unusual dimensions of 66ft. 2in. long, 50in. wide, and $\frac{11}{20}$in. thick. The plates, which have been made to the order of Messrs. Furness and Withy, shipbuilders, West Hartlepool, are to be used in the construction of trading vessels for an American firm.

New Companies.

COLNE ENGINEERING COMPANY LIMITED.—This company was registered on the 5th inst., with a capital of £10.000, in £1 shares, to adopt an agreement made on the 24th ult., between E. G. M. Donnethorne and B. Baker, for the purchase of the business heretofore carried on at Twickenham, under the style of the "Colne Engineering Company," and to carry on the business of electrical, gas, and mechanical engineers. The greater part of the regulations of Table A applies. Registered by B. Baker, 15, Great George-street, Westminster, S.W.

THOMAS ROBINSON AND SON LIMITED.—This company was registered on the 5th inst., with a capital of £120,000, in £10 shares, to purchase, acquire, and carry on the business now carried on by Thomas Robinson and Son Limited, at Railway Works, Rochdale, and conduct the businesses of engineers, boilermakers, millwrights, and similar undertakings. T. N. Robinson, C. J. Robinson, A. M. Robinson, L. Shawcross and F. Taylor are to be the first directors; qualification, 50 shares; remuneration, £200 per annum. Registered by Walker and Rowe, 8, Bucklersbury, E.C.

COVENTRY ELECTRIC TRAMWAYS LIMITED.—This company was registered on the 10th inst., with a capital of £25,000, in £5 shares, to acquire railways, tramways, and roads in the United Kingdom; to apply for working powers; to adopt an agreement made on the 5th inst. between the Electric and General Contract Corporation Limited and A. G. Jones; to construct railways and tramways; to promote electric and other works; and to equip and work with electric, steam, mechanical, and animal, or other motive power, the railways, etc., of the company. Most of the rules of Table A apply. Registered by R. Byron Johnson, 49-50, Parliament-street, S.W.

THOMPSON BROTHERS LIMITED.—This company was registered on the 9th inst., with a capital of £7000, in £1 shares, to acquire the business of gas-oven makers, engineers, and ironfounders, now carried on by David Thompson and C. E. A. Renny, at Crown Point Foundry, 11, East-street, Leeds, under the style of "Thompson Brothers"; and to continue the business acquired. The first directors are to be named by the subscribers of the memorandum of association; qualification, £100; remuneration to be decided by the shareholders in their general meetings. Mr. David Thompson is the first managing director of the company. Registered by Jordan and Sons, 120, Chancery-lane, W.C. Registered office, 11, East-street, Leeds.

ROLLASON'S WIND MOTOR COMPANY LTD.—This company was registered on the 5th inst., with a capital of £25,000, in £1 shares, 350 of which are founder's, and the remainder ordinary, to carry on the business of electricians and mechanical engineers, suppliers of electricity for the purpose of light, heat, motive power or otherwise, and manufacturers and dealers in all apparatus and things required for, or capable of being used in connection with, the generation, supply, accumulation, and employment of electricity. The number of directors is not to be less than 3, nor more than 7; qualification, 100 ordinary shares; remuneration, chairman £150 per annum, ordinary directors £100 per annum, and percentage of profits. Registered office, 3 and 4, Great Winchester-street, E.C.

WEST HAMPSTEAD FOUNDRY AND ENGINEERING COMPANY LIMITED.—This company was registered on the 9th inst., with a capital of £15,000, in £1 shares, to acquire and take over as a going concern the business of mechanical and electrical engineers, ironfounders, boilermakers, manufacturers of locks and safes, now carried on at West Hampstead, and known as the "Hampstead Foundry"; to enter into an agreement for that purpose; to purchase patents, etc., and to continue the businesses above mentioned. The number of directors is not to be less than 3, nor more than 8; qualification, £100; remuneration, £50 per annum, and any other sum the shareholders decide upon in general meeting. Registered by W. H. Dunn, A.C.A., 93A, Ethelburga House, E.C.

SAXBY AND FARMER LIMITED.—This company was registered on the 4th inst., with a capital of £25,000, in £10 shares, to adopt an agreement made on the 21st ult., between R. Plumber and C. Hodgson, executors of the late J. S. Farmer, who carried on business as "Saxby and Farmer," and C. G. Hodgson; and to undertake the business of electricians, mechanical engineers, manufacturers of railway signals, locking apparatus, and safety appliances. The number of directors is not to exceed 5, unless determined to the contrary, and the first members of the board are C. Farmer, C. Hodgson, and A. J. Constable; qualification, £100; remuneration, C. Farmer £200 per annum, C. Hodgson (while he continues managing director) £1500 per annum and 10 per cent. of the net profits of the company. Registered by Faithful and Owen, 11, Victoria-street, S.W.

HUDSON SMOKE BURNER AND FUEL ECONOMISER COMPANY LIMITED.—This company was registered on the 6th inst., with a capital of £6000, in £10 shares, to purchase patents and like conferring the right to use any secret or other information as to any invention which the company may think capable of being profitably dealt with; to enter into an agreement for the acquirement of a patent for improvements in the method of and apparatus for the consumption of smoke in the furnaces of steam boilers and the like, and to carry on the business of ironfounders, mechanical engineers, and other similar trades. The number of directors is not to be less than 3, nor more than 7, the first being H. G. Hudson, W. Cliff, and J. W. Blackburn; qualification, £200. Registered by Jordan and Sons, 120, Chancery-lane, W.C. Registered office, 62, Albion-street, Leeds.

The Metal Market.

PRICES CURRENT.

LONDON, May 15.

COPPER opened easy at £43 10s. cash, or a loss of 3s. 9d. from Friday, and gradually declined, owing to the weakness of the financial position, to £43 6s. 3d. three months, meanwhile passing at £43 17s. 6d. to £43 15s., and the end of July and middle of August at £43 15s. Later in the day selling orders caused a further giving way, three months moving from £43 13s. 9d. to £43 11s. 3d., and to £43 10s. after the official close, when £43 8s 9d. was taken for a week short of three months. The market closed weak, with cash offers at £42 18s. 9d., or a decline of 15s. on the day. Sales, 700 tons. Settlement price, £43. English tough, £47 to £47 5s.; best selected, £48; strong sheets, £55 to £55 10s.

TIN, under the same influence as copper, has been pressed for sale. Business began at £86 for late July, and afterwards early July was done at the same figure, year in sellers' option, seven days' notice, also passing at £85. Realisations then reduced late May 10s. to £90 10s., other May dates following at £90 7s. 6d., and after official hours £89 12s 6d. was taken for the former position. The middle of July moved from £85 15s. to £85 10s., and an odd lot of Mount Bischoff made £91. The close is weak, with cash about 22s. 6d. down and forward dates 10s. lower. Sales, 150 tons. Settlement price, £90. English ingots, £93.

PIG IRON opened quiet, with an easier tendency, and business was done at 40s. 3d. cash for 1000 tons, at which the market closed quiet, Scotch being about a 1d. lower. Other kinds unchanged. Settlement prices: — Scotch 40s. 3d.; Middlesbrough, 33s. 7d.; hematite 44s. 8d.

TINPLATES inactive, with prices unchanged.

LEAD is quiet, with a declining tendency. Spanish, £9 10s. to £9 12s. 6d.; English, £9 15s.

SPELTER has a nominal market at £17 10s., sellers.

ZINC SHEETS. — Silesian are inactive at £20 15s. Belgian steady. V. M. brand, £21 5s. ex-ship, and £21 2s. 6d. f.o.b. Antwerp.

OFFICIAL CLOSING QUOTATIONS.

	To-day. £ s. d.	£ s. d.
COPPER—		
G. M. B.—Cash	43 0 0	—43 10 0
" Three months	44 11 3	—43 18 9
TIN—		
Fine foreign—Cash	90 0 0	—90 10 0
" " Three months	85 10 0	—86 0 0
Australian—Cash	90 10 0	—91 0 0

PIG IRON—

	Scotch. Cash. s. d.	Scotch. 1 m'th. s. d.	Middlesbrough. Cash. s. d.	Middlesbrough. 1 m'th. s. d.	Hematite. Cash. s. d.	Hematite. 1 m'th. s. d.
Close	40 3	40 6	33 7½	33 9½	44 8	44 10½
Prev. close	40 4	40 6½	33 7½	33 9½	42 3	—

GLASGOW, May 15.—Business on the pig-iron market was very quiet, but the tone was surprisingly steady considering the financial disturbances reported all round. Only some 5000 tons Scotch sold at 40s. 4d. to 40s. 3½d., sellers remaining over at the former. A couple of lots of Cleveland sold at 33s. 8d. cash, and one lot of Cumberland hematite at 44s. 7½d. cash. The close was steady. The shipments of Scotch last week were 5330 tons, being an increase of 66 tons on the corresponding week.

QUOTATIONS:—

	Scotch. Cash. s. d.	Scotch. 1 m'th. s. d.	Middlesbrough. Cash. s. d.	Middlesbrough. 1 m'th. s. d.	Hematite. Cash. s. d.	Hematite. 1 m'th. s. d.
Highest	40 4	40 7½	33 8	33 9½	44 8	44 10½
Lowest	40 3½	40 7½	33 8	33 9½	44 7½	44 10½
Close	40 3	40 6	33 7½	33 9½	44 8	44 10½
Prev. close	40 4½	40 7	33 7½	33 9½	44 8	44 10

Official Gazette.

Partnership Dissolved.

R. THORNEWILL and A. THORNEWILL, engineers, ironfounders, and iron merchants, Burton-on-Trent, under the styles of Thornewill and Warham and John Thornewill and Son.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Adjudication.

ROBERT CROSTHWAITE, Queen Victoria-street, E.C., and Norwood-road, Tulse Hill, S.W., iron merchant.

Order made on Application for Discharge.

SAM WALMSLEY and JONATHAN LEACH INGLE (trading as Walmsley and Ingle), Bradford, engineers and machine makers. Discharge suspended for six months ending Oct. 18.

Letters to the Editor.

We do not hold ourselves responsible for opinions expressed by correspondents.

The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.

Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

COMPOUND STEAM ENGINES.

To the Editor of THE MECHANICAL WORLD.

SIR,—I have noticed an article in your issue for April 28 respecting a compound steam engine made by Ross and Duncan, of Glasgow, wherein I perceive the cylinders are in the proportion of 4 to 1. This, I think, is rather unusual, and from my varied and long experience I consider that about 3 to 1 is best, and this, I think, is most usually employed. The cylinders in this case are 17½ and 35ins. I would reduce the low-pressure to about 30½ins., and divide both sizes by 4, which would be about 9 and 15ins., and use two high and two low-pressure cylinders, keeping the steam on the whole length of the stroke, as I always consider the latter part of the stroke is decidedly the best and most effective. All the working parts would only require to be one-fourth of the strength, and would be in the same proportion; the engines would work easier, better, and last longer, and they could be started either fore or aft without resorting to artificial means. There would be a considerable reduction of the working parts, only one slide valve to each pair of cylinders. A description is given in the "Engineer" for June 6, 1890. I would dispense with the costly, lumbersome, and expensive air pump and surface condenser, now that such high steam pressures are used, which would be more than compensated for by having a good water heater fixed on the smokebox of the boiler to utilise the waste heat both from the boiler flues and the exhaust steam.

MECHANICAL AND CONSTRUCTIVE ENGINEER.

Longsight, May 15.

TESTING AND ANALYSIS OF IRON AND STEEL.

To the Editor of THE MECHANICAL WORLD.

SIR,—As Messrs. Leadbeater and Hodgson say the mistake is very obvious—so obvious, in fact, that it is a wonder it ever was allowed to appear,—I shall look forward with interest to the gravimetric method for estimating Mn as MnO_2.

LOOKER-ON.

Wigan, May 13.

Miscellaneous Items.

The idle steam tonnage in the Tyne was reduced from 109,242 tons on March 31 to 88,783 tons on April 30—a decrease of 20,459 tons.

The Chicago and North-Western Railroad Company have 27 miles of main track in Chicago, which will be elevated at a cost of £4,800,000.

The inventor of the telephone newspaper, Herr Theodore Puskas, has just died in Budapest. He was regarded as one of the leading electricians of Hungary, where he started the telephone exchange.

The Woodbridge wire-wound gun, now being built at the Watertown Arsenal, America, will shortly be finished. It weighs 30 tons, is 27ft. in length, wire wound, and is expected to throw a 600lb. projectile 15 miles.

A start will shortly be made with the first section of the Trans-African Telegraph, intended to connect Capetown and Cairo. The material is being selected, and it is expected the line will be open to Uganda within three years.

The new Morgan Line steamer, "El Rio," built at the yard of the Newport News Shipbuilding Company, is the largest all-steel merchant steamer built under the American flag. She is 406ft. long, with 48ft. breadth of beam, and has a gross burden of 4500 tons.

The Royal Observatory at Copenhagen will be fitted with a new photographic telescope, similar to the one just fixed at the Upsala Observatory in Sweden. It will be a double telescope, optical and photographic, having two parallel tubes connected with one another.

Near the Furness Railway at Lindal, where the subsidence occurred in the line some months ago, there are the signs of the highway giving way, particularly the highway to Ulverston. The road had to be diverted on account of its unsafe condition owing to the iron mines underneath it, and now both the old road and the new are gradually sinking, and in the opinion of miners and experts both are likely to completely subside.

The Norfolk and Western Railroad in the United States is adopting 60ft. rails, with a view to getting rid of half the usual number of joints, and thus reducing the work of maintenance. These rails were first laid on seven miles of track on the Maryland and Washington division. They weighed 67lb. per yard, and were cut with mitred ends. Since then 18 miles of line have been laid with rails of the same length, but weighing 85lb. per yard, and having square ends. Both sections of track have proved satisfactory.

A process of making pipes of cement and iron is now being tested in France. A framework of iron is embedded in cement mortar. Bars of an I section are used, which are rolled as long as possible and then wound into a helical form, the pitch of the helix being determined by the section of the iron and the pressure to be withstood. Tanks are also made on the same principle, the pitch of the helix being lessened at the bottom, where the pressure is greatest. The coefficient of expansion of iron and cement being about the same, no trouble is experienced from changes of temperature. The cement protects the iron from rust.

The Government of New Zealand has authorised an inquiry to be made as to the application of electricity as a motive power to gold-saving batteries, the electricity to be generated by the power of a waterfall within a few miles of the field. There has been considerable difficulty in saving the gold from the Kuaotuna (Coromandel) ores, owing to the cost involved in working the batteries. Some time since representation was made to the Governor of the cost of taking coal and other material on to the field for treating these ores. A suggestion was also made that electricity generated by water-power at the falls, some eight miles distant, could be used as a motive for battery purposes. The ore is low grade. The Government has decided to send Mr. Fletcher, electric engineer, Otago, and Mr. Gordon, inspector of mines, to report as to what can be done in the matter.

Queries.

Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

OIL MERCHANTS.—Will any reader give me the London address of the Cleveland Lubricating Oil Company, U.S.A.?—A.H.

CLEANING BOILER TUBES.—Will some reader describe a useful tool to remove hard, thick scale from cross tubes in a vertical boiler? Tubes 9in. diameter and 4ft. 6in. long.—NOVICE.

JIGS FOR DRILLING.—The Americans often use what is termed a jig for drilling. Will anyone kindly give a sketch, together with drill?—DRILLER.

CHURCHILL SLIDE VALVE.—Can any correspondent inform me who are the makers of the "Churchill Patent Slide Vale"? Any information would be thankfully received.—J. M.

RETEMPERING EDGE TOOLS.—Will any reader inform me if there is any method of tempering pattern maker's chisels and gouges that have been burnt in a pattern-shop?—CYMRO.

WARSOP AERO STEAM ENGINE.—Any information about the working of the above engine, tried about 1870, such as the effect on the boiler, cylinder, piston rod, etc., will oblige —M. R.

GALVANISING. — Can any reader inform me whether it is possible to do galvanising on a small scale, say 3 or 4cwt. spelter bath? also the process of preparing cast-iron work for the bath?—T. J.

CASE-HARDENING FURNACE.—Will any practical reader give a sketch of a good furnace for case-hardening purposes, cutter-heating, etc., gas, liquid fuel, or coke, or the name of any maker of such? — LISTER AND CO., Keighley.

KEYS, COTTERS, ETC.—Can anyone inform me what kind of steel is used for making keys and cotter pins as used on most engines? The keys that are bought seem to be of better quality than the so-called mild steel as sold at very little more than the price of fair merchant iron.—STEEL.

STEAM REVERSING GEAR.—I should be much obliged if any reader will explain the working of a steam reversing gear for locomotives, which I have seen on the following railway companies' engines:—Glasgow and South-Western, Mersey Tunnel, and South-Eastern. A sketch would assist me.—F. TURTON.

THEORETICAL DIAGRAMS. — Will any reader sketch and describe the theoretical indicator diagrams which would be obtained from a set of triple-expansion engines, having given —Load on safety valves, 150lb.; height of barometer, 30in.; ratio of cylinder volumes, 1, 2¼, 5; total ratio of expansion, 8.—HYPER.

METALLURGICAL FURNACE.—Can any reader furnish me with a scheme for supplying the heating power necessary for a metallurgical laboratory situated in iron-ore mining district, and where no gas is available? A small muffle furnace would be required, in addition to the ordinary heating power, and the fuel used is charcoal. Accommodation only required for one chemist.—H. S.

CONDENSING COIL.—In constructing a condensing worm and tank, what amount of coils are necessary so that the distilled water may be quite cold, and what would be the quantity of water in tank to obtain the result? How can I arrive at the final temperature of water originally cold which has passed through 500ft. run of 1½in. pipe, the pipes being immersed in a tank containing water at a temperature of 200° Fah.?—CALOR.

WIRE ROPE TRANSMISSION.—I want to transmit 60H.P. from a turbine running at 400 revolutions per minute, by a travelling wire rope to a mill main-shaft running at 250 revolutions, distance 100yds., and at 70yds. from turbine, a right-angle bend. There is a slight rising gradient from motor to mill. Will someone kindly tell me size of pulleys to use, diameter or circumference of rope, and speed? Can I drive direct without an intermediate gearing or countershafts? What is the best method of turning the angle, and should one or more ropes be used?—MINER.

DYNAMO WINDING.—Can any reader oblige me with the proper winding for an E.P.S. type dynamo of the following dimensions (in centimetres), so as to obtain at least 4 volts 3 ampères at a speed of about 2000 revolutions per minute:—Length of magnet bar, 11; length of yoke piece, 8·4; width of magnet and yoke piece, 5·3 each; depth of yoke piece, 2·5; thickness of magnet bar inside bobbin, 3; diameter of armature, 5; length, 5·3; air gap, ½ millimetre all round? It has a laminated armature, with 12 interruptions $\frac{3}{16}$in. wide by ¼in. deep, and a corresponding number of sections in the commutator. The magnets are of Swedish cast iron. I have tried it with 2000 turns of No. 38 B.W.G. on the field and 120 turns of No. 26 B.W.G. on armature, but can get hardly any current.—E. P. S. TYPE.

FEED PUMPS.—In working out feed pumps for common high-pressure engines, Molesworth says, p. 493 —"Take cubic contents of cylinder and one steam passage and multiply by 4, and divide by proper specific volume for given pressure." Why multiply by 4? There are only two cylindersful of steam discharged to one revolution or one stroke of the pump Then, again, should not the cubic contents of cylinder be taken to cut off only? For instance, if steam is cut off, say, at half-stroke, and initial pressure be 100lb., the specific volume for which is 270, we find a great difference from the plan of taking the full cylinder at the average pressure, which at 100lb. initial pressure will be 75 average, the specific volume for 75 being 353, not to mention the difference in the two cubic capacities. Feed pumps worked out according to Molesworth's rule and others always come out much too large—nearly three times. I shall be glad if some reader will explain this. — COLD WATER.

Replies.

Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

J. O. L.—Apply to Messrs. Edwards and Barnes, Birmingham.

F. C.—Apply to Messrs. Huntley, Bourn and Stevens, Reading.

SPRING.—Apply to Messrs. Salter and Co., West Bromwich.

"CŒUR DE TIGRE."—It is impossible to answer your query from the data given.

MOTOR.—Why not use a small oil engine such as supplied by Messrs. Crossley Bros.

F. G.—Yes, we think so. Apply to the Chief Constructor, Portsmouth Dockyard.

STEAM.—"The Tabor Indicator" (3s. 6d.) will suit you. It may be had from our office.

J. FIELDHOUSE.—Yellow prussiate of potash is generally used; it can be obtained from any large drysalter's or druggist's.

ENGINE FITTER.—Yes; it is quite possible any good modern indicator will meet your requirements, such as the Crosby or the Tabor.

SPIRAL.—We do not think you will succeed in obtaining tubes which will stand such treatment, but you might apply to the Credenda Tube Company, Birmingham.

H. GREENWOOD.—Indiarubber will withstand the heat of steam for a considerable time, but gradually hardens and cracks on its surface, afterwards breaking away in lumps.

BEGINNER.—We cannot supply a complete set of the numbers containing the articles, but we can obtain a copy of a reprint of them in book form (price 6s.) in two or three weeks time.

H. DANBY.—A great deal depends upon the conditions of the load and the material composing the beam. If of cast iron, the arrangement shown in sketch A would be best. If in wrought iron, the method shown in sketch B.

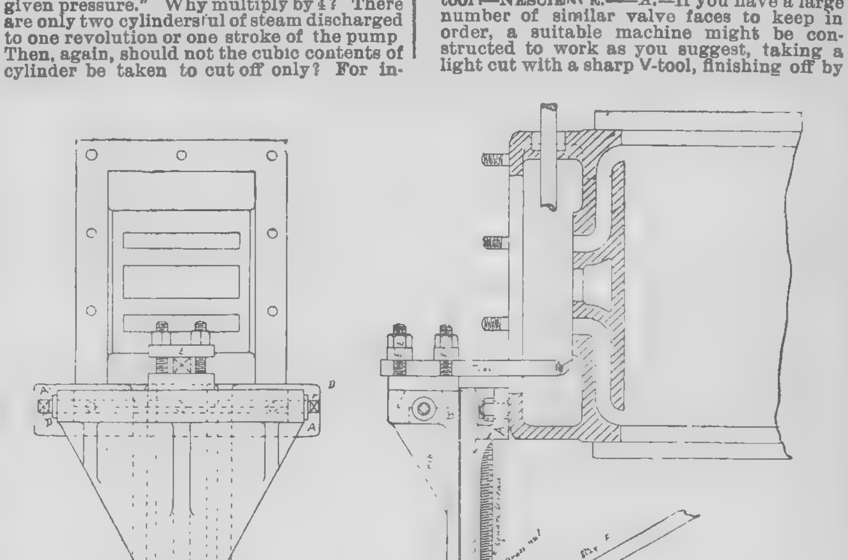
NEW SUBSCRIBER.—(1.) Taking the allowable, stress at 10,000lb. per square inch, the thickness should be ⅝in. (2.) The Worthington Pumping Engine Company, Queen Victoria-street, London, supply such a pump.

PERDIDO.—Your best plan would be to write to manufacturers of drawing materials, some of whom you will find advertise in our columns. Place the matter fully before them, and try to either dispose of your rights for a lump sum or at a fixed royalty for each one sold by them.

NOVICE.—You do not give full particulars of the valve. Multiply area of valve in square inches by pressure of steam, and by length of lever in inches from fulcrum to centre of valve spindle, and divide by the whole length of lever in inches. This will give the weight to place at the end of lever. There are many simple text-books on this subject which give very easy examples.

CLEANING GALLOWAY TUBES.—Can any reader inform me of some acid with which I could remove thick scale from a number of Galloway tubes which are not accessible by scrapers?—BOILER.——*A.*—Hydrochloric acid (spirits of salts) will remove scale, but if tubes are very large it would be expensive.—T. MANWARING.

FACING SLIDE VALVE FACES.—I require a hand appliance, not expensive, suitable for getting up the faces of slide valves of portable, traction, and other engines, say when the valve face is some 3in. to 5in. from the valve-chest cover face. Are there no small hand-lever appliances which can be screwed on to a stud and used for working a broken file or similar tool?—NESCIENCE.——*A.*—If you have a large number of similar valve faces to keep in order, a suitable machine might be constructed to work as you suggest, taking a light cut with a sharp V-tool, finishing off by



hand with a suitable scraper; or a milling device might be made to take a cut of about ⅝in. wide each setting, one cut to overlap the previous one to about ¼in. For odd sizes, however, and different makes, of engines the outlay would be out of proportion to the result. —OTTO (Liverpool).——*A.*—I think you will find the accompanying drawing of a planing machine for facing portable, traction, and stationary engine slide valve faces to meet your requirements. As will be seen by the drawing, it consists of a compound slide rest, bolted to the steam chest by the same studs

as used for the steam chest cover. The T part of the bottom slide rest A has a slot nearly the whole length so as to suit the studs at any centres. It must be made sufficiently high to clear the studs of the steam chest cover, and to allow the top rest B to pass over them. The tool is moved backwards and forwards in the direction of the piston by means of the hand wheel C, the feed being regulated by a small hand wheel or handle at D. The setting of the tool will give the depth of the cut, which can be adjusted by means of the nuts and plates E. The length of the slide rests A and B will be settled by the size of the largest cylinder you require to face. It will be as well to make the top slide rest G as long as the bottom rest H will allow, so as to avoid the rest G springing when the tool is at the end of its travel, especially when planing a large valve face. The stay F is bolted to the cylinder by one of the cylinder cover studs. It will sometimes happen that the steam chest opening is not as long as the valve face: if so, you can either set the tool, or, if it is only the matter of about 1in., you will be able to do it by turning the tool round and starting the cut from opposite end to that shown. If the drawing is not sufficiently clear in detail, I shall be pleased to give you further information.—FIDELITY.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

1st May, 1893.

8636 MACHINERY for ELEVATING and CONVEYING COAL, GRAIN, LIME, ETC. J Ruscoe.
8691 AUTOMATIC WATER GAUGES. G M Marchant.
8694 INTERNAL COMBUSTION "HEAT" ENGINES. E Butterworth.
8699 MACHINES for MAKING JOINTS WITH METAL CLAMPS.* N Browne. (*J Temler, Russia.*)
8701 PIVOT MILLING PLATES.* F W T Braeunig.
8703 APPARATUS for HEATING and CIRCULATING WATER in STEAM GENERATORS. R Watson and R D Munro.
8705 WHEELS. E C F Otto.
8708 SELF-LANDING HOISTS. A Wadsworth.
8714 WATER MOTORS. W H Symons.
8719 SELF-CANTING ANCHOR. C W Matthews.
8722 DYNAMOS or ELECTRIC MOTORS. A J Boult. (*O Patin and L Levavasseur, France.*)
8723 POCKET OIL-CANS, AIR PUMPS, ETC. C Halliday.
8728 STEAM GENERATORS. A G Mumford.
8729 STEAM GENERATORS. A G Mumford.
8733 RAILWAY-SIGNALLING APPARATUS. J Page.
8734 POSTAL or OTHER TUBES USED for the TRANSMISSION and PROTECTION of PAPERS. P Tyrer.
8739 EARTH EXCAVATORS. W H Finlayson.
8742 APPARATUS for TRANSMITTING SIGNALS or ELECTRIC IMPULSES.* D Young. (*C Cuttriss, United States.*)

2nd May, 1893.

8743 AXLE BOXES. J Walker and W Tate.
8744 FASTENERS for BANDS and BELTS.* W S H Schmidt.
8745 RAILWAY CHAIRS. R Smith.
8746 EXHAUSTING PUMPS. C V Boys.
8747 METHOD of FIXING COPPER BITS by MEANS of TWISTED WIRE. J White.
8759 ILLUMINATING GAS. J H R Dinsmore.
8764 GOVERNING STEAM ENGINES. H S Booth.
8765 METALLIC CASES. A J Rees.
8776 METALLIC PISTONS. T Shepherd and others.
8781 SHAFTS for MARINE and OTHER ENGINES, MASTS for SHIPS, TENT POLES, ETC. C W Dawson.
8788 APPARATUS for DRILLING or BORING of METALLIC BODIES.* J Whitehall and G Bedford, jun.
8790 APPARATUS for ASCERTAINING the CAPACITY of HOLLOW VESSELS. W P Thompson. (*G Vollner and F Lehmann, Germany.*)
8794 METALLIC WHEELS.* W P Thompson. (*J W Bettendorf, United States.*)
8798 PETROLEUM MOTOR. E Capitaine.
8801 TUBULAR STRUCTURES.* J H Brown and others.
8802 ELECTRIC LIGHTING of RAILWAY CARRIAGES. O S Ruddock.
8808 ELECTRIC ACCUMULATORS or STORAGE BATTERIES.* H Lehmann.
8809 RAILWAY FOG-SIGNALLING APPARATUS.* G Musgrave and others.
8811 CLINOGRAPH or MATHEMATICAL DRAWING INSTRUMENT.* W H Brown.
8812 ELECTRICAL APPARATUS for RAISING the SHUTTERS of TELEPHONE INDICATORS. C D Abel. (*Société Générale des Téléphones Reseaux Telephoniques et Constructions Electriques, France.*)
8815 ROTARY SIEVES.* J Anthon.
8821 BAND SAWS. L H Fornander.
8822 HYDROCARBON VAPORISERS and BURNERS.* J H Mathews.
8823 TANKS for HYDROCARBON BURNERS.* J H Mathews.
8825 HYDRAULIC MOTOR. E Edwards. (*A Glenck, Russia.*)
8827 POSITIVE PRESSURE BLOWERS.* J W Wilson.
8831 WATER METERS. B A Collins.
8832 ROUTE INDICATING MAP, ESPECIALLY ADAPTED for USE in the ROOFS of RAILWAY CARRIAGES. G W Bacon and L Richards.

3rd May, 1893.

8843 ROTARY ENGINES. W S Draper.
8846 SAFETY VALVES for STEAM GENERATORS. H B Buckland and others.
8850 INSTRUMENTS for RECORDING and REGISTERING SPEEDS or PRESSURES. E C Mills.
8853 WOOD SCREWS. W F Needham.
8854 STEAM TURBINES and WHEELS. The Hon. C A Parsons.
8855 SETTING and WORKING of STEAM BOILERS. W Geipel.
8859 SCREW-DOWN TAPS.* J Dollheiser.
8860 VALVE GEAR of DUPLEX DIRECT-ACTING ENGINES.* H W Morley and T Holehouse.
8861 FLEXIBLE TUBES. G Hookham.
8864 OIL or GAS ENGINES. A E and H Robinson.
8868 SCALE or INSTRUMENT for USE in MAKING DRAWINGS. W P Thompson. (*L M Dieterich and L Weisz, Austria.*)
8873 WATER-MOTOR. W Smith.
8876 THE PROPELLING of BOATS. A Swanson.
8885 WATER GAUGES.* W Haigh and E Richardson.
8887 REFRIGERATING APPARATUS and APPLIANCES. R Long.
8888 STEAM PACKING SUITABLE for OTHER FLUID PRESSURE. J Yates.
8890 DRAW-OFF TAPS.* Beck and Co. Ltd. and others.
8892 LATHE SLIDE RESTS.* G Strickland (Count D Catena).
8895 STUFFING-BOXES. H Strassburger.
8899 KNITTING MACHINES. C H Aldridge.
8900 APPARATUS for SOFTENING WATER. C E Gittins.
8901 MICROPHONES. E J P Mercadier and J M Anizan.
8906 GOVERNORS for MOTIVE POWER ENGINES. J C Stevenson.

4th May, 1893.

8913 GAS and OIL MOTOR ENGINES. J Southall.
8914 AUTOMATIC VALVE-CLOSING ENGINE for APPLICATION to EXISTING VALVES in WATER MAINS. J Davison.
8925 ELECTRICAL TIME-TRANSMITTER and ALARM. H L Leconte and L A Meyer.
8932 MINERS' SAFETY LAMPS.* F Gothot and A Hüing.
8934 NUT-LOCK DEVICE. F Gothot and A Hüing.
8938 MEANS for JOINING the RAILS of RAILWAYS. R C Hindshaw.
8943 DIVIDING and MILLING MACHINE. G Sonnenthal. (*L F Burkhardt, Germany.*)
8948 EXHAUST PIPES of LOCOMOTIVES.* J B Hartigan.
8949 HYDRAULIC LIFTING or HOISTING MACHINERY. H W Umney.
8951 DREDGERS or EXCAVATORS for CLEANING the BEDS of PONDS, POOLS, RIVERS, ETC. R and B Bomford.
8952 ELECTRIC ACCUMULATORS.* F W Ellermann.
8953 RESILIENT MATERIAL for PACKING PURPOSES. J Mardon and H Rogers.
8957 APPARATUS for COUPLING and UNCOUPLING RAILWAY CARRIAGES and WAGONS.* L Pix.
8960 INSTRUMENTS for ASCERTAINING DISTANCES.* V von Ziegler and C Hager.
8961 SMOKE DIFFUSER. H E Newton. (*The Sächsische Glasfabrik Actien Gesellschaft, Germany.*)
8964 SEPARATING and PURIFYING METALS. J A Mays.
8967 GAS and OTHER MOTIVE-POWER ENGINES. H M L Crouan.

5th May, 1893.

8969 SWITCHING ARRANGEMENTS at TELEPHONE EXCHANGES and SUBSCRIBERS' INSTRUMENTS. G J Somerville and R McLean.
8977 SCREWS for WOOD or OTHER MATERIALS. F Clarkson and others.
8980 PACKING for PISTON RODS. J H Hargreaves and others.
8981 GAS TAPS or COCKS. A Little and W D Reid.
9000 AUTOMATIC WATER GAUGES for STEAM BOILERS.* H B and J S Watson.
9005 COMPOUND and MULTIPLE CYLINDER STEAM ENGINES. R W Muir.
9029 PIPE COUPLING or JOINTS. J Davison and R G Bell.

6th May, 1893.

9050 AXLE PULLEYS. J Collins and A B Milne.
9051 METALLIC PACKING. J E L Ogden.
9055 CUPS for REGULATING the FLOW of OIL to SURFACES REQUIRING LUBRICATION. R Baird.
9060 STEAM ENGINES. J Virtue. (*J Virtue, jun., South Africa.*)
9077 STEAM GENERATING APPARATUS. C A Allison. (*G E Belmore and A J Treat, United States.*)
9085 PUDDLING FURNACES USED in the MANUFACTURE of IRON and STEEL. S Meredith.
9090 PARALLEL WORKING of ALTERNATING ELECTRIC CURRENT GENERATORS SPECIALLY APPLICABLE in CONNECTION WITH GAS ENGINES. W S and C R Boult.
9092 "CAPPING" of ELECTRIC INCANDESCENT or GLOW LAMPS. W S and C R Boult.
9104 PLUG. D Brown.
9117 SAND-MOULDING MACHINES.* A L Teetor.
9126 ELECTRIC ARC LAMP. J Jeyes.
9127 COUPLING of WHEELS of LOCOMOTIVE ENGINES and RAILWAY VEHICLES. L A Brière.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to SIR H. READER LACK, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

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FRIDAY, MAY 26TH, 1893.

The Late Mr. A. E. Cowper.

MR. A. E. COWPER, whose death we regret to say took place on the 9th inst., was a well-known figure in the gatherings of the engineering societies in London, and frequently took a leading part in the discussions on papers relating to steam-engine economy—a subject in which he was particularly interested. Born in 1819, he was apprenticed at the age of 14 years, and while still an apprentice he invented the ordinary fog signals for use on railways. The first trial of these signals, now so well known, was made on the Cardiff Railway. During this period he was also working on Captain Ericsson's invention and in railway work. In the year 1846 Mr. Cowper went to Birmingham to the factory of Fox and Henderson, where he invented an improved method of casting railway chairs. The next year he assisted in founding the Institution of Mechanical Engineers, and was on the council from its foundation. He was elected president in the session 1880-1. In 1851 he was closely connected with, and actually did, most of the contract drawings and the machinery for making the parts for the International Exhibition. While still with Fox and Henderson he designed the roof of the Birmingham station, New-street, the first large span station roof (211ft. span). In the same year (1851) he started in business for himself as a consulting engineer, which he continued to the time of his death, having recently taken his eldest son, Mr. Chas. E. Cowper, into partnership. Perhaps to engineers Mr. Cowper's name is more closely connected with the hot-blast stove than with anything else. His first patent for this regenerative firebrick stove being taken out, subsequently many other patents were taken out, the latest of which was that of 1887 for moulding bricks in the form of a honeycomb. Upwards of 500 of these regenerative stoves are now in use. He also took out patents for compound engines and for marine engines. In 1879 Mr. Cowper exhibited his writing telegraph, which excited considerable interest at the time. Mr. Cowper was a member of the Iron and Steel Institute, the Institution of Electrical Engineers, and various other institutions. He acted as a juror to various exhibitions, and more than once for the Royal Agricultural Society. In 1884 he was selected to deliver the special lecture on the steam engine before the Institution of Civil Engineers. In 1887, in conjunction with Dr. Anderson, he made experiments on the modern equivalent of heat, and the paper of his colleague was read before the meeting of the British Association.

A Remarkable Railway.

IF the scheme elaborated by an Italian engineer for the construction of an elevated railway in Naples is carried into execution, Italy will possess one of the most remarkable undertakings in the world. As far as length is concerned, the projected line is not of great importance, but the boldness of the idea and its originality are very striking. Let the imagination conceive the hilly portion of a town connected by means of viaducts and towers with that part lying at a low level, and the substance of Mr. A. Avena's project will then be readily understood. The handsome and populous part of Naples radiating from Via Roma has only communication with the Corso Vittorio Emmanuele, the San Martino hill, and the (at a still higher level) new Rione del Vomero, by means of narrow tortuous streets, many of them being impracticable for carriage traffic. It is between these two extreme localities that the proposed electric railway is to form a connection. The line is to be carried on two metallic viaducts, each divided so as to form a double way, one for the operation of electric cars and the other for pedestrians. A masonry tower, 325ft. high, is to be built in the Via Roma, and from this the first viaduct, 1180ft. long, will be carried to the Corso Vittorio Emmanuele, where it will terminate in the base of a metallic tower 490ft. in height. The second viaduct, 950ft. long, and branching out of this tower some distance below its summit, will pass over the San Martino hill and end on the ground level at the new Rione del Vomero. The viaducts will be carried on pyramidical metallic towers having masonry foundations, and the masonry tower at the beginning of the first viaduct and the metallic tower connecting the two viaducts will each be provided with staircases and capacious lifts for conveying passengers up and down. Passengers entering the cars at either end of the line will not be compelled to change their seats on arriving at the metallic tower, as the cars will be automatically placed on the lifts for ascending to or descending from the highest viaduct when the cars will continue their way to either terminus. Generating stations will be provided at each terminus for producing current for lighting and power purposes The undertaking, a concession for which has been granted, would provide a splendid view of the whole of Naples.

The Hydraulic Testing of Boilers.

IT is quite time that the existing ideas as to the value of the hydraulic testing of boilers were revised, for notwithstanding the importance attached to this test by Board of Trade officials, it is liable to mislead in a large number of instances. Mr. Hiller, the chief engineer of the National Boiler and General Insurance Company Limited, refers in his last report to the fact that many second-hand boilers are offered for sale on the strength of their having stood hydraulic tests much exceeding the pressures at which it is proposed to work them, but which careful inspection has shown to be quite unsuitable. Boilers which are seriously defective frequently withstand hydraulic test to a much higher pressure than that at which they would fail if they were worked under steam, and the reason for this apparent paradox would appear to be that the steady pressure under hydraulic test is quite different in its effect in setting up stress on a steam boiler to the conditions of ordinary work. Thus when a steam boiler is being worked some of the principal straining effects are due to the inequalities of temperature and the varying expansion or contraction resulting. In some boilers the stresses set up in this way are sufficient to cause rupture and explosion, as, for instance, the ring seam rips in long cylindrical externally-fired boilers, and in many other cases the movement causes severe grooving, as in the case of front ends of "Lancashire" boilers or the furnace crown plates of ordinary small vertical boilers. Further variations and stresses are also set up by the fluctuations of steam pressure from time to time. It is quite evident that hydraulic test fails to verify, or otherwise, the strength of the boilers as regards these racking strains due to the varying temperature and pressure, and it is this fact mainly which constitutes the essential difference between the conditions of hydraulic tests and those existing in ordinary work, and, taking account of this great difference, the behaviour of a boiler under the hydraulic test cannot by itself be considered as a reliable guide to its safety. But in certain cases the hydraulic test, when judiciously applied, is a useful accessory, especially in the detection of leakages, as a test of the stiffness of flat surfaces, and in certain exceptional cases where the interior of the boiler is not accessible for any examination.

The Deptford Station.

THE expectations cherished a few years ago concerning the commercial and electrical prospects of the Deptford generating station of the London Electric Supply Corporation have not been realised, and the present condition of affairs tends to show that it will be a long time before the difficulties experienced at and in connection with the station are overcome. It was originally believed, by erecting large works and concentrating in them huge machinery on a certain system for the supply of hundreds of thousands of lamps, that excellent commercial results would be obtained. These anticipations have, however, proved to be unfounded. To say the least, the position has been most unfortunate from the beginning. The working of the two 5000H.P. dynamos has been abandoned, perhaps for a long time to come, and the two machines of 1250H.P. are not without drawbacks. At present the plant at work consists of the two 1250H.P. dynamos, two of 625H.P., which have been remodelled and their output increased from 8500 lights to 12,500 lights each, and a new dynamo of 300H.P., driven by a set of triple-expansion condensing engines which have recently been put down, whilst another machine of 300H.P. will shortly be installed. These 300H.P. dynamos will enable the day load to be worked with greater economy, and they will constitute a useful auxiliary power, as they can be worked in parallel with the larger machines with considerable economy. The trunk mains have proved satisfactory during the past year, and the length of the distributing mains has been increased to thirty-five miles. As showing how great a reduction has been effected in the cost of producing a Board of Trade unit, it may be mentioned that in 1891 every unit produced cost 10·14d., of which 4·61d. comprised generation—that is, coal, sundry stores, repairs, and maintenance, coal alone costing 2·36d. per unit. In March, 1892, the total cost had been reduced to 8·06d., and in March this year the cost was diminished to 5·71d., of which coal represented 1·31d. per unit for that quarter. It is hardly possible that the price of coal will fall—the probability is rather that it will advance, considering the adverse influences affecting the coal market; but the other items (4·40d.) bringing the cost up to 5·71d., are practically stationary, and will be reduced in proportion to an augmentation in the number of lamps lighted. Thus even with an increase of twice as many lamps as are now connected, the only extra expenses to be incurred will be mainly in the case of coal, so that with the practically stationary cost per unit (4·40d.) in the case of the other items, the total cost of producing a unit will be diminished in proportion to the increase in the number of lamps connected to the mains, and, therefore, in the number of units sold. In other words, the greater the number of lamps, the less the relative cost of producing a unit. The misfortunes—breakdowns and fires—attending the works have caused a great difference in the number of lamps supplied. In November, 1890, at the time of the fire at the Grosvenor Gallery station, there were 38,272 lamps connected. The supply being thereby stopped, these customers ceased to be consumers, so that when operations were resumed there was scarcely a lamp connected to the distributing mains. However, in May, 1891, 23,000 lamps had been again put on circuit; at the beginning of 1892 the number had increased to 35,100 lights, and at the end of the same year to 46,197 lamps, whilst down to the middle of the present month the number has been advanced to 56,200 lamps. If the same rate of progress during the past two years obtains in the next two years, the company expect to be out of trouble. The plant at Deptford is now capable of dealing with 90,000 lamps, the transmission from there to the transformer distributing stations being effected at 10,000 volts. In this connection it is surprising to note how very considerable is the loss of current by leakage and in conversion. For instance, of the total current generated and put in the mains—the distance of transmission being between four and five miles,—only from 42 to 45 per cent. has been accounted for, the whole of the remainder of from 55 to 58 per cent. having disappeared! Fortunately the causes of this have been discovered (it is partly due to energy losses in the house transformers), and to remedy this new transformers are being introduced which will increase to 70 per cent. the utilisation of the total current generated. As Mr. J. Staats Forbes, the chairman of the corporation, stated last week, the undertaking was started on too magnificent an idea, and that the practical conclusion of many people was that it would have been wiser to have commenced with a smaller unit, instead of having two dynamos of 5000H.P. and two of 1250H.P. However, by the remodelling of and improvement effected in the machinery and transformers, by the present more economical method of working, and by the increasing confidence of the public in the capability of the company to maintain an efficient supply of light, it is hoped that in a year or two the undertaking will emerge from an unsatisfactory state into one of complete prosperity.

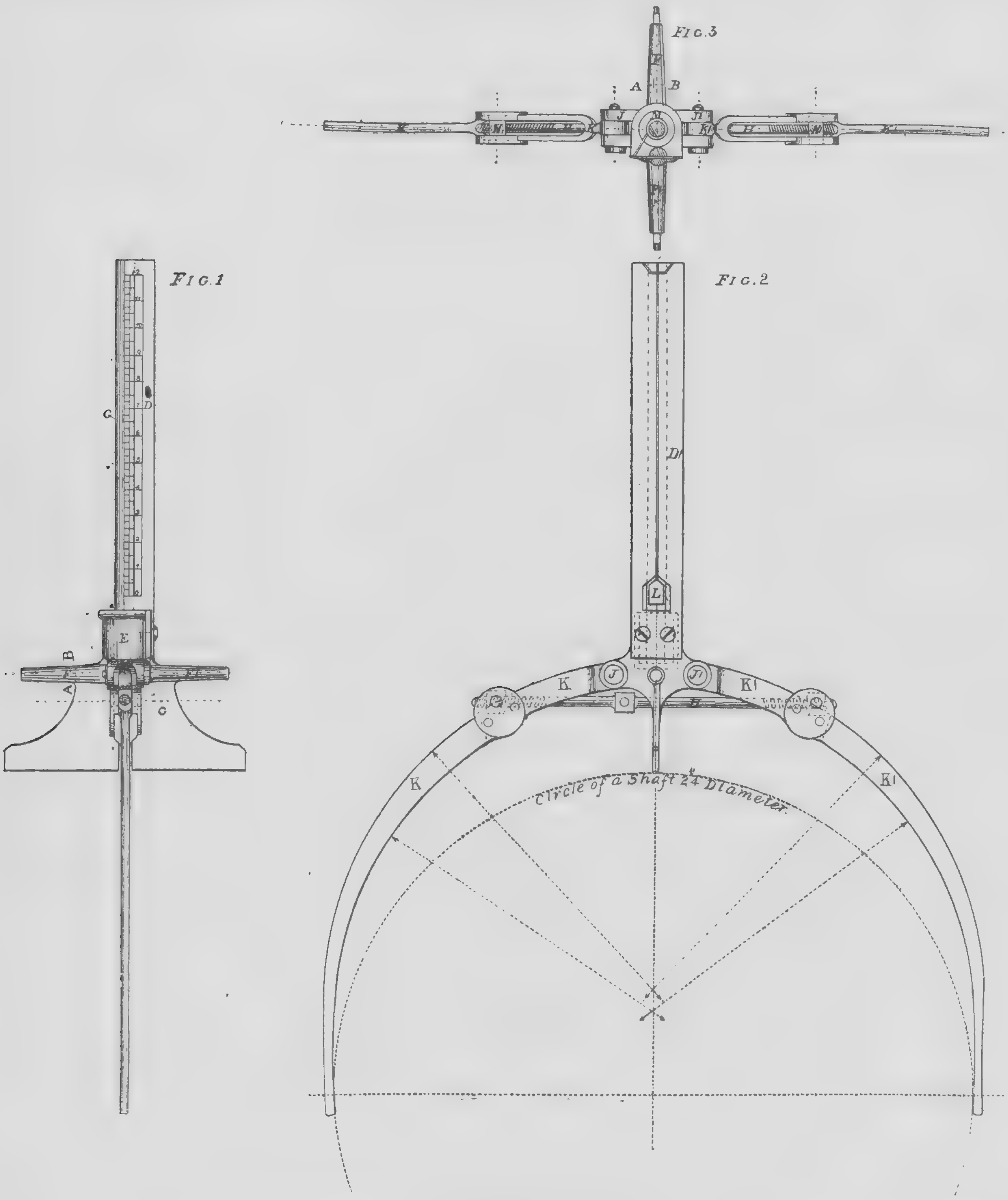
Increasing Towing Power.

ON some of the French watercourses where the current runs at a rapid rate, a system of chain haulage has been adopted to assist steam tugs in towing barges up the river against the stream. Briefly, the chain, which is fastened at each end, lies at the bottom of the river. It passes between guides at the stern or bow of the tug, over rollers and guides, and round nearly the whole of the circumference of the haulage pulley or drum, which is driven by gearing from the engines. Leaving this pulley the chain passes over a similar series of rollers, between braking pulleys, and then is permitted to fall into the river. With a view to increase the speed, a system of "magnetic adhesion" has been devised by M. Bovet, and has recently been tested on the Seine. It consists essentially in combining in the haulage pulley a magnet, the sides of the groove forming powerful pole pieces, which are short-circuited when the chain engages in the groove. By this means the pull on the chain, and therefore the speed of the boat, are increased. Whether any economy is gained does not appear clear, but this method is said to have been adopted by one of the towing companies on the Seine.

Cumming's Shaft Leveller.

THE apparatus shown in the accompanying illustrations has been specially designed for levelling shafting on ship-board, but it may also be used for ordinary shafting, mill-gearing work, etc. The instrument consists of a glass tube C, a scale and plumb plate D D′, and a brass casting E F F′, G J J′, the latter forming a socket at E for holding the tube C. There are also two tubes F F′ for connecting rubber tubes to; a straight-edge G; a right and left-hand screwed rod H connected to the two legs K K′ by means of the nuts N N′, for gripping the sides of the shaft, etc., the legs K K′ being jointed to the casting E F G, etc., at J J′; the tube C, fitted watertight into the socket E by means of a wooden ferrule M; and the plummet L, used for setting the instrument vertically.

to the branch pipe F′ or F on each instrument, and the open end of the idle branches plugged watertight. Water, with a little colouring matter added, is then poured down into one of the glass tubes until it reaches the height marked 1 on the brass scale D. After this has been done, on looking at the tube in the other instrument (say the after one, the liquid having been poured in at the forward one), if the ship and the shaft are level the liquid will be found at the same height in both tubes. Should, however, the ship, or engines, be down by the stern, say 1in. in a length of 20ft., and the distance between the two instruments be 20ft., then the difference in the height of the liquid between the two tubes will be 1in.; or in the former tube the height of liquid will be at 1in., and in the after tube at 2in. In the event of the ship and crankshafts being level, an instrument placed at the ders, all the line of tunnel shafting from the outer bearing of the stern tube should run in the same line if the shafting is true —*i.e.*, for every length of 20ft. there should be a drop of 1in. For example, an instrument is fixed on one of the crankshafts at the outside end of one of the journals, another is placed 20ft. abaft that on one of the tunnel lengths of shafting if the shafting is in line with the crankshafts and the instruments connected by the rubber tubes, the latter being of course kept below the level of the zero mark on the scales—on putting in the liquid, the difference of level between the instrument on the crankshaft and the one on the tunnel shaft should be 1in., or exactly the same as the difference in level between the two points 20ft. apart on the crankshafts, the liquid standing at 2in. in the tube on the tunnel shaft when it is at 1in. in the tube on the crankshaft; any variation from



CUMMING'S SHAFT LEVELLER.

In trying the line of shafting on board a steam vessel, three instruments are frequently used at one time, similar to the ones shown in our illustrations Figs. 1, 2, and 3, the *modus operandi* being as follows:—In the first place, the vessel must either be on the ground or afloat in still water. The level of the crankshafts is ascertained in the usual manner from the planed faces on the bedplate, or from the turned faces on the cylinders. When this has been found to be correct, one instrument must be put in position at or near the forward end of the forward bearing of the forward crankshaft, and another instrument set at or near the after end of the after bearing of the after crankshaft, both instruments being adjusted plumb the athwartship way, and the straight-edge on each set fair on the fore and aft line of their respective crankshafts. A rubber tube is then connected aft end of the crankshafts, another on the tunnel shafts midway between the stern-tube stuffing-box and the one on the after end of the crankshafts, and a third on the shaft at the stern-tube stuffing-box, all the instruments being set at the same distance from the centre line of the shafts and coupled by means of two rubber tubes—when the liquid has been poured in at the forward tube till it rises to 1in. on the scale it will be found to have reached the same height on the other two—*i.e.*, providing the line of shafting be straight. Should it be out of line, either up or down, it will at once be seen by the liquid being either above or below the figure 1 on one or both of the after tubes.

In the event of the engines being placed in the ship so that the crankshafts in a length of 20ft. show to be down or off the level 1in., those shafts being at right angles to the vertical centre line of cylinders, tha means that the shaft is the amount of variation out of line either up or down in that 20ft. length.

Another example:—Suppose it were desired to try the line of shafting of a screw steamer floating, say, 5in. by the stern in a length of 100ft., two instruments are set on the crankshafts 20ft. apart, as before mentioned (the shafting here being level with the ship on even keel), it will be found that the liquid will stand at 1in. in the forward tube and at 2in. in the after tube. After this has been ascertained, shift the forward instrument into the tunnel, say at 50ft. from the one on the after part of the crankshaft, and place a third instrument on the shaft close to the stern-tube stuffing-box, say 100ft. from the forward one, the whole three instruments being connected by rubber tubing as before, the idle tube branches of the forward and after instruments being plugged, and all three being set plumb athwartships with their respective straight-edges laid fair fore and aft on the line of shafting, and all equidistant from the centre line of shafting—on filling with liquid to 1in. on the scale of the forward tube the liquid will stand at 6in. in the tube at the front end of the stern-tube stuffing-box, 100ft. aft, and at $3\frac{1}{2}$in. in the tube on the tunnel shafting, 50ft. from the forward instrument—*i.e.*, providing the shafting is in line with the crankshafts. Should the shafting be up or down from the line of crankshafts, the level of the liquid in the tubes will show accordingly.

As before stated, these instruments can be used for putting up and levelling lines of shafting in mills and factories, and may be used for a variety of other purposes; but the apparatus was originally designed for testing lines of shafting on ship-board, the legs K K′ being fitted for setting the instruments firmly and truly on the shafts; or arrangements for placing them in bearings or on straight-edges can be made as required to suit the work.

Messrs. D. B. M'Callum and Son, the well-known engineers and boiler makers, of Bute Docks, Cardiff, are the manufacturers, and will be very pleased to show the apparatus and give any further explanation required as to its use, etc.

Pump Valves.*

THERE are few mines that can do entirely without a pump for draining the water out of them. The subject of pump valves should therefore be of almost universal interest, and to many it is of very great importance.

In common with many others, it has been my lot to come into contact with much

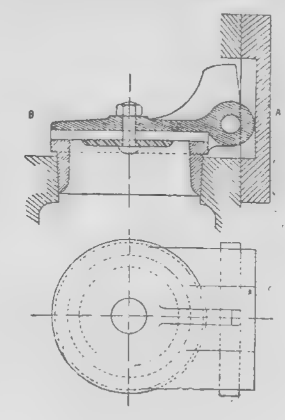


FIG. 1.—CLACK VALVE.
(Scale $1\frac{1}{2}$in.=1ft.)

pumping machinery; and it is because of the great variety of pumping valves that are in use that I thought it would be desirable to have the same recorded in the "Transactions" of our institute.

The following observations will, as the title shows, be confined to one detail of the

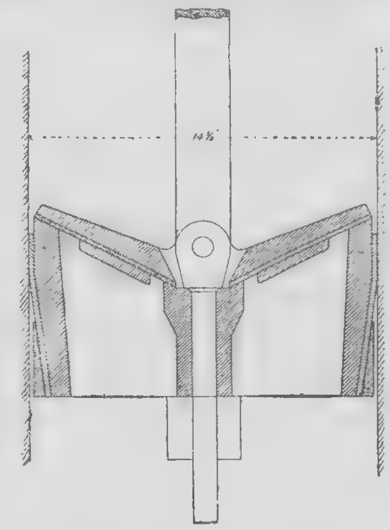


FIG. 2.—LIFTING BUCKET.
(Scale $1\frac{1}{2}$in.=1ft.)

pumping machine—namely, the pump water valves. As my own observations on the subject are necessarily limited, I have extended the paper so as to include many varieties I have not seen; and I take this opportunity of thanking those who have helped me to present this paper as it is. Of those valves of which I have had personal experience I can speak with certainty, and give figures to bear out the opinions stated. Those I have not used I can only criticise, and those members who

* Paper by Dugald Baird, read before the Mining Institute of Scotland.

have had experience of them will put me right where wrong. After our experiences are recorded, the results will, I trust, be of value to the institute.

In dealing with a subject so varied as that of pump valves, classification is necessary. These may be divided into three groups:—First, single and double-beat flap valves; second, single-beat disc valves; third, double-beat disc valves.

These groups will be subdivided as they are treated. But before the details and particulars of the various kinds of valves are gone into, a few remarks on them in general will be necessary.

As everyone knows, the object of a valve is to prevent water which is flowing through

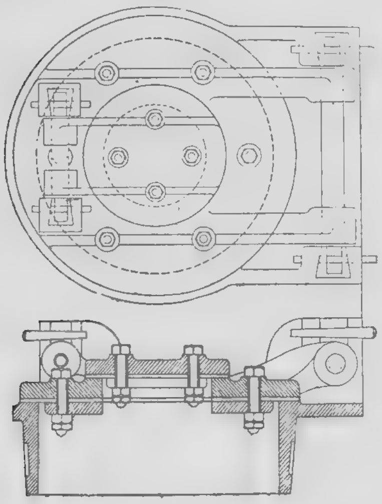


Fig. 2A.
(Scale ¾in.=1ft.)

a pipe or part of a pump from returning; and the leading idea to be kept in view when designing or selecting a valve is to have one that will give the least possible resistance to the flow of the water, and still shut quickly and noiselessly, and to be water-tight and durable. The valve that will fulfil these requirements is an ideal valve, and what is desired will never be fully attained; but many valves come very well up to these conditions.

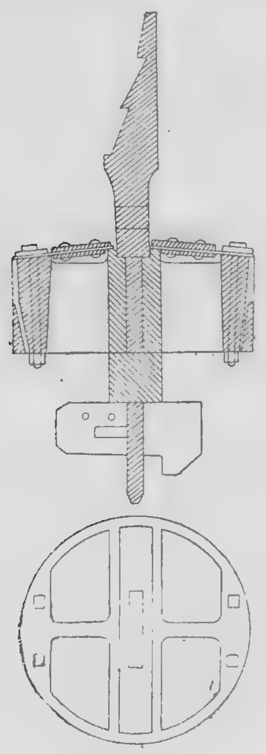


Fig. 3.
(Scale ¾in.=1ft.)

The general statement may here be made that many valves that are suitable for one class of work may be totally useless for another class. It is of importance to choose a valve suitable for the class of work to be performed. The different classes of work may be subdivided thus:—With clean water, gritty water, hot water, cold water, and acid water; having fast action, slow action, high vertical lift, and low vertical lift. Under these heads many of the conditions of a pump are found. In pumping clean water, which is cold and free from acid, and forcing a moderate height, there are few difficulties to be surmounted so far as valves are concerned. Almost any of the valves to be referred to could be adopted. But if we have gritty water of high temperature, with acid in it, fast action, and high head, then it takes special knowledge to be able to select at once the proper valve, and so not to require to find out by costly experience the valve wanted. Between these two extremes lie all known cases.

For perfectly clean water there is no great need for mounted valves, but where the water is gritty no other valve should be used. Unmounted valves, or metal-to-metal valves, are not at all suitable for gritty water, but are a source of much trouble. Where hot water is pumped and the temperature exceeds 100° F., unmounted valves are the proper thing, and mounted valves should be discarded; and when the water contains sufficient acid to attack the iron, then brass valves must be adopted — in fact, brass is a good metal for a valve or valve seat, whether the water contains acid or not.

In flap valves there are two outstanding kinds—single flap and double flap. Fig. 1

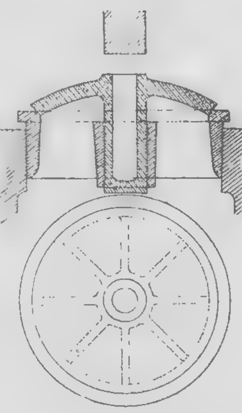


Fig. 4.—Mushroom Valve.
(Scale 1in.=1ft.)

is an example of a single-flap valve. This is, so far as I know, the oldest and simplest form of valve, and is generally called a clack valve, probably owing to the sharp click it makes when closing. Too often the lift of it is not regulated, and much slip is the result, as well as an alarming increase of pressure, occasioned by the sudden closing of it. This style of valve is still much in use for dook pumps, and makes a really good valve for pit use.

It is, as a rule, hinged with leather; but where the pressure is heavy, the construction of iron hinge shown is good—in fact, is essential. In all cases the lift should be regulated, and the amount of lift in this—the simplest of all valves—is fixed in a similar way to all others.

If the pump is going fast, small lift should be given; if going slow, large lift is required. I fix the limits of the lift in this valve at from 20° to 45°, according to the speed of the pump. Should slip occur in a valve, or a leak be suspected, the simplest way to discover it is to listen for it; and the most efficient way to listen is

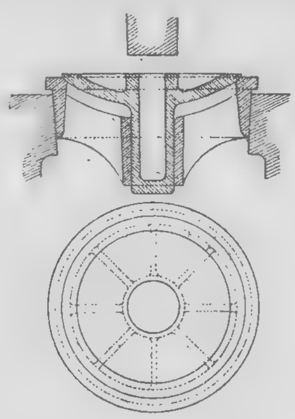


Fig. 5.—Dish Valve.
(Scale 1in.=1ft.)

to adopt the pitman's style of placing your foot-rule firmly against the valve box while you catch the other end of it with your teeth, then, placing your fingers in your ears, you can diagnose what is the matter inside with as much accuracy as a medical doctor can his patient. Of course, these valves, in common with all valves, will only work efficiently when fixed according to their construction. It would be wrong to fix a single-flap valve hinge down in a horizontal line of pipe. They work best with the hinges up in that case, whereas the great majority of other valves will not work at all well unless fixed horizontally. All valves should be fixed in such a way as to allow the water, after it has got through the valve, to get away as freely as possible, and great care should be taken to see that there is plenty of space for the water to flow in after it gets through the shell of the valve. It would be wrong to fix this valve with the hinge at A if the exit for the water was near A, but right if the exit was at B.

The next valve is the double-flap or butterfly-lid valve, familiar to every colliery man, and almost universally adopted for bucket and clack valves of lifting sets. They have been long in use, and for lifts up to 30 fathoms are not likely to be superseded. They may be used for greater lifts than 30 fathoms, but in that case it is necessary to dispense with the leather hinges and adopt iron ones. The style shown in Fig. 2 is very suitable for such, and does for both bucket and clack. The setting of the lids at an angle, as shown, makes the path of the water more natural, and reduces the slip to a minimum.

Another modification is shown in Fig. 3; but in this case the lids are hinged in leather at the circumference of the bucket shell, instead of at the centre, as is usually the case. The special benefit of this style, and of that in Fig. 2, is that there is little chance of the sword getting to work loose in the shell, as is always the case in a heavy lift or a fast-driving low lift, owing

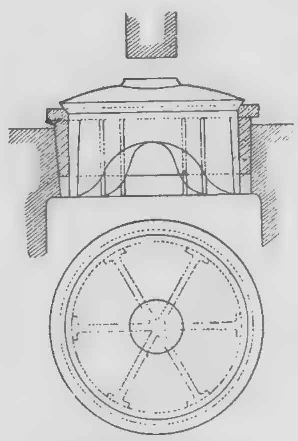


Fig. 6.—Wing Valve.
(Scale 1in.=1ft.)

to there being one or two plies of leather between the cross of the sword and the shell of the bucket.

The most important valve of this group is that shown in Fig. 2A, the double-beat leather-mounted hinge valve, well known as the Cornish double-beat valve. It has long done service, and is likely to retain the important place it takes among pump valves of large dimensions up to 60 fathoms head. The lift of this clack is good, but nothing great, as the leather mounting, (the weakest part of it) gives way and requires renewal. There is seldom or never a guard to regulate the lift of this valve. It takes what it wants. For slow speed this is right enough; but for speeds over 100ft. per minute the lift should be checked. The lift of this valve, with a head of 50 fathoms, will average three years, or 4½ million beats. For the sake of lightness and strength, the seat and lids are usually made of malleable, cast, or crucible steel.

The next group is single-beat disc valves, and under this group there are many different kinds. Under this group I will place the various valves called mushroom

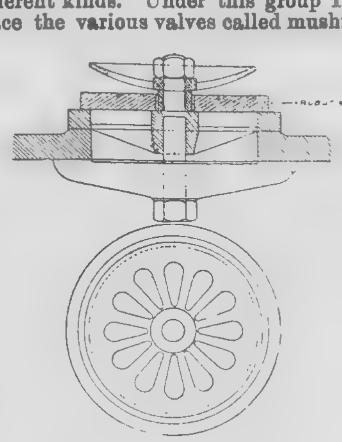


Fig. 8.—Disc Valve.
(Scale 1in.=1ft.)

valve (Fig. 4), dish valve (Fig. 5), wing valve (Fig. 6), mitre valve (Fig. 7), and such like. Although strictly speaking they are not disc valves, still they have the same sort of action, but are generally made with no provision for keeping them water-tight, so that they are only suitable for use when the water pumped is free from grit. As this paper is mainly to deal with valves suitable for ordinary dirty pit water, I only give these metal-to-metal valves a passing notice, as they are really unfit for pit use, and if used are always leaking more or less, and require to be often faced in a lathe. However, in such service as doing duty in a boiler feed pump, they are in their right place.

A very common and efficient form of disc valve is illustrated in Fig. 8, where an indiarubber lid works on the top of a grating and is regulated for lift by a saucer. As air pump valves they are very useful, except when there is an extra amount of lime in the condensing water, in which case the grating holes are liable to be filled up and require frequent cleaning. To meet this the superior but more expensive valve shown in Fig. 9 should be adopted. Fig. 8 valve may also be used as an ordinary pit pump water valve when the head does not exceed 15 fathoms, and will be found very efficient, as it seldom leaks even with gritty water, but it is more liable than the ordinary butterfly style to retain gags in the form of pieces of coal and chips of wood. The other weak point in it when applied to pit work is that when the head exceeds 15 fathoms the rubber gets squeezed into the open spaces of the grating and gets cut. To make it wear longer, it is a good plan to have the grating holes cast at an angle

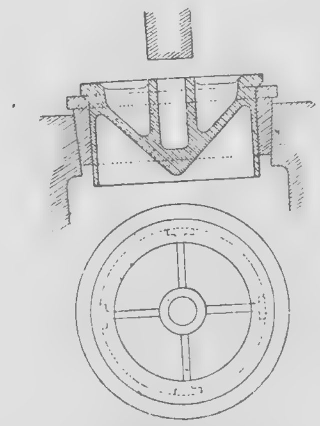


Fig. 7.—Mitre Valve.
(Scale 1in.=1ft.)

so as to cause the water to act on the rubber disc obliquely, and thus the disc is made to revolve, and, owing to the whole surface getting a share of the biting process, the lid lasts longer before it requires to be renewed. A similar revolving action is got by having the edges of the rubber disc serrated obliquely at the circumference, as in Evan's patent valve, the weight being only 64 per cent. of the same when new.

Fig. 9, already referred to, is a disc valve with rubber lid, the construction of which is easily seen from the drawing. This valve has been in use in mines for many years, and, so far as I know, has a record for durability that far outstrips any other form of valve. I give an extract from a letter I had from a colliery manager who had this style of valve in a heavily-watered pit. Someone had been saying to him that he could improve on them, and he replied:—"I believe they could be slightly improved upon; but when a clack can go for about 20 years without a single penny of expense, I think it not bad." I have never heard of them failing, except in a case of over-driving, in which case the

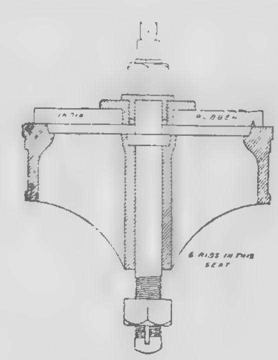


Fig. 9.
(Scale ¾in.=1ft.)

bottom nut wore slack, cut the cotter-pin through, and, the nut falling off, the lid lifted right out of its place. The first place this valve gives way is at A. The plate through time gets worn down past the flush, and the rubber gets cut. Altogether this is a superior pit water valve, and seldom fails to give satisfaction.

(To be continued.)

The "Royal Forth," a large steel four-masted sailing ship, was launched from the yard of Messrs. Ramage and Ferguson, Leith, on the 15th inst. The dimensions are:—Length, 318ft.; breadth, 45ft. 3ins. moulded; depth, 28ft. She is a vessel of about 3000 tons net, and has a carrying capacity of 4780 tons.

The Lubrication of Marine Engines.*

My reasons for bringing this paper before your notice are chiefly that however well designed and well proportioned a marine engine may be, unless friction be overcome successful results cannot be obtained, and because in many ways the various methods of dealing with this matter are defective—in fact, they may rather be called adders to the evil, than antidotes of it. I think if a few of the most prominent defects and most radical evils were brought before this institute, and properly discussed and thrashed out, some greater notice would, perhaps, be given by designers and by marine-engine builders to the various means of applying lubrication, which would prove beneficial to the engine itself, and give a better and more satisfactory condition of life to the engineers. I would here specially ask you to note that my intentions are to speak only of some of the methods in use of supplying lubrication to the bearings, and not to the lubricating materials themselves; so numerous are these latter, and so effective and beneficial is their work, according to the various and many advertisements we see, that one wonders why such things as hot bearings ever occur. If we were to work out the various percentages of savings which we are told will accrue through the use of these many so-called lubricants, taking no consideration of the many special ways they can be applied, I think the results would be a *minus* expenditure instead of the very heavy positive one we find. It is not, however, to this I ask your attention, but to the different methods of distributing these lubricants throughout the engine, showing what I consider the defects, and likewise making a few suggestions as to the more necessary remedies which may be, without any great trouble, adopted.

Defective lubrication has, probably, given a great deal of worry and anxiety to most of those who have been brought closely in contact with marine engines, and in an institute like this there are very few, I presume, who have not had some experience of the working and troubles of marine engines. On that account I have written this paper, hoping it may induce a discussion on the methods of lubrication generally, and perhaps lead to much-needed improvements. You may not coincide with my ideas, but I am sure a discussion on this subject will be very beneficial, and tend to useful and practical results, advantageous alike to the shipowner and the marine engineer. Great loss of power must be a necessary consequence of improper lubrication; and loss of power caused through this one defect alone must of a certainty mean a great augmentation of the amount of coal, which, in the engineering department of to-day, is, without a doubt, the most serious point of consideration. But not only will this defect show in the coal accounts: it must appear as a serious item in the repair accounts as well, and in the end must certainly touch the pockets of shareholders and owners. It has been stated by Dr. Thurston, Professor of Cornell University—who, I think, may be quoted as one of our greatest authorities on the subject,—in his work on "Friction and Lost Work," that the average loss per annum for an engine of 100H.P., working a mill, is £100 through friction alone; and if this is computed for a mill engine, it can be no less in a marine engine—in fact, I think the percentage would be greater. A considerable sum, you will say; but I think it comes very near the mark, when we look back and consider in our own experience the number of shafts we have had to lift, the number of brasses worn through and requiring new metal, and the time and trouble expended in adjusting bearings which, if they had at the first received more attention in the arrangement of oil supply, would have lasted a much greater length of time. The first cost of a few more feet of piping, and a few more oil boxes distributed around the engine room, would be very small compared to the great after expense which must follow through the lack of them.

Many arguments might be brought to bear on this subject, and I trust many will be; but I would here ask all to note that the references in this paper are solely to vertical marine engines. No doubt they could be applied to other machinery as well, but as this institute is principally composed of marine engineers or those intimately connected with marine engineering, and the greatest number of marine engines of the present day are of the vertical type, I hope all arguments will be considered accordingly.

Lubrication may be divided into two classes—external and internal. Let us first consider the external. Among the principal parts of a marine engine are the crankshaft and its various bearings, to which too much attention can never be given. In boring out bearings for a crankshaft the general rule is to give a greater diameter than the shaft which has to revolve in them, a difference which may vary with the engineers, but in all cases the hardest points to come into action are the top and bottom centres and a gradual enlargement towards the sides. In the method of supplying lubrication to these bearings to which I refer, all oil holes are bored through the top centre; and to enable the bearing to receive sufficient oil to overcome friction, the outlets have to be greatly enlarged and oil channels cut all over the bearing surface. This I consider wrong, and one of the greatest defects in anti-friction that can occur in any bearing in which the shaft has a revolving motion, as the sides of the bearings (and by that I mean any part away from the top and bottom centres) must have the greatest division of the two metals—in other words, less friction; therefore the outlets should be distributed into that space, so that the shaft in revolving will carry its lubrication with it, drawing its supply as from a reservoir—inducing a better flow down the oil pipe, instead of retarding it, as must take place when the pipes lead directly to the top centre of the bearings. Were it not for the enlargement of the oil tubes and the channels cut over the surface, no lubrication would take place in these bearings at all.

Nearly all main bearings are now fitted with white metal, or some other less tenacious metal than the brass itself, and is generally fitted in the outer brass or cast iron, as the case may be, in strips of about 4ins. in width, having one division on the top centre into which the oil holes are led. This method has its advantages; but I think if this white metal were to be divided into three surfaces—that is, with two intermediate divisions only,—we would give the bearing a better opportunity to distribute its work through all the component parts. We require only the bearing surface equal to the diameter of the shaft to ensure a correct bearing, and, instead of the arrangements of the present day, we get the oil supplied into the space on either side, and the whole metal is left as bearing surface on the bottom and top centres—the principal points of these bearings.

I do not think any great inconvenience would be caused by making this alteration. A difference would be required in the design of the cups; but if this can be proved to be the better way of lubrication, and in consequence add to the life of both bearing and shaft, surely the designers can make the necessary alterations without any great trouble—for it is just as easy to design a thing properly as improperly. I consider, therefore, that all bearings in which the working part has a revolving motion should be supplied with lubrication not on the top centre, but at some point away from that centre. Then each side of the bearing will always have a better supply, and as a result we would have less friction and consequently greater power.

Let us now consider the lubrication of the crankpin. The same defect is here seen as in the main bearings, and if it is wrong in one case, here it must show with greater force. The principal defect in crankpin lubrication, I think, lies in the method of supply from the boxes as at present fixed in many marine engines. Many of you will still have in your recollection—because it is only of late years the system has been discarded—the long telescopic pipes which carried the supply to a centre box; a more extravagant way could, I am sure, never have been designed. It always seemed to me that half the supply was taken up in lubricating the pipes alone; and let the engineer in charge be as careful as he could, still there was always a great waste, for the pipes never seemed dry. This has happily been improved upon, although it still remains in some of our older ships. The method of to-day, although without a doubt a great improvement upon this old style, I think falls far short of perfection. Let us trace the connections. Generally we have a box fixed high up on the cylinder lagging, with pipes leading to another cup fixed on each side of the connecting-rod jaw; from these cups lead other pipes (usually one from each) to another cup, fastened to the centre of the connecting rod, or at such a distance as to give clearance from the bottom corner of the guide, and to be handy for any oil to be given as the rod is working. From this cup run three pipes: one to each side and one to the centre. Now, from this last cup run three outlet pipes; but it has only two supplies, and these two, in five sets of engines out of six, lead directly over the side outlets; the centre pipe gets its supply only by chance. I do not say it never gets any, but I consider that every outlet should have its own special supply. From the first box there should be sufficient oil supplied to guarantee each of the pipes leading into the brass getting its own proper amount regularly, and on no account should this most important bearing be left to chance lubrication, as in some cases at present. We know it is necessary for oil to reach this bearing. It must surely, therefore, give greater satisfaction if the engineer can be certain that every drop reaches its intended part. With engines running at the high speed of to-day, and with the long connecting rods now in use, it is impossible for this pin to be oiled except automatically; let the greaser be ever so good, there must still be a great percentage lost when oil has to be supplied in this offhand manner. How many crankpin bearings to-day can be run without using the water service, which, although at times a blessing, when considered relatively to the life of the shaft and bearings is far otherwise? Many an anxious watch is passed, and many a gallon of oil is wasted, through the defective supply to a bearing. Yet it can be easily remedied. Of course, the old saying may be brought in: "It has gone for so many years, it can surely do now." But I hope I have sufficiently shown the defect to justify a remedy, as follows:—Place the outlet holes not on the top centre, but somewhere on the sides; give each hole an independent supply pipe, and, if the engine is properly balanced, there will be a much better working pin, and with better working we have less friction, and, consequently, longer life to both pins and bearings.

(*To be continued.*)

* Paper by Mr. W. M. Ross, read before the Institute of Marine Engineers.

The Birmingham Association of Mechanical Engineers.

At the monthly meeting of the above association a paper was read on the "Construction of Weighing Machines," by Mr. G. W. Davis, of Messrs. Averys, Birmingham. The chair was occupied by Mr. A. Driver (president), and there was a good attendance of members. The lecturer commenced by giving a brief historical account of weighing machines from their earliest ancient types to those of modern construction in use at the present day, afterwards classifying them under their different heads, treating fully each kind and illustrating them by means of photographs or by samples of machines. He dealt first with the scale beam and balance, in which the load was below the beam, describing the mode of construction and (according to the delicacy, etc., required) the position of its knife edges. After treating at some length upon the varied and chief properties with balances of varying grades of delicacy, the lecturer asserted the desirability of operating with a constant load in order that there should be the same displacement of the needle for the same excess or decrease of load, whatever that load may be, inasmuch as the structure of the beam will deflect on the slightest strain. A balance was exhibited clearly indicating a difference of $\frac{1}{1000}$th part of a grain; also an American torsion balance of rather delicate construction. In this latter balance thin wires were substituted for knife edges, and these wires were horizontally strained (put into tension). The torsion of these wires was used for indicating want of balance. The friction which is set up in the torsion of the wires is exactly counterbalanced by placing the centre of gravity of the beam above the wires. But considering that light wires when horizontally strained are extremely weak, the lecturer considered the machine as useless in its present form. After dealing with counter weighing machines on the vibrating and accelerating principles, and strongly recommending the former as the most accurate, Mr. Davis passed on to the simple steelyard, and illustrated two great disadvantages connected with butchers' steelyards, which disadvantages, the lecturer pointed out, have, after a lapse of 2000 years, been remedied by a steelyard constructed upon novel lines by Messrs. Averys. It consisted in placing one centre having a double knife edge within a tumbler, which revolved upon a centre pin and instantaneously altered the length of the load arm with displacing the steelyard (as in the old type), for the purpose of substituting a new fulcrum; the blade also was provided with a runner or loop having projecting horns, which, while allowing for free movements of the same, instantly arrests the poise weight when the blade has assumed a given angle from the horizontal, and thus preventing it from running down the blade and damaging the notches in so doing. Mr. Davis then described various types of platform weighing steelyards, illustrating the advantages of using heavily-laden poises, and entirely dispensing with the separate loose weights hung upon the counterpoise rod at the extremity of the steelyard. Another type contained a revolving polygonal bar, graduated in different standards upon its respective faces, thereby dispensing with separately graduated steelyards, and the wear and tear of their vital parts (centres) in the process of substitution. Afterwards the self-registering steelyards were illustrated and fully explained, whereby a record of the weight was impressed upon a ticket by the aid of hardened steel figures, and how a record of 1000 indications may be kept impressed upon a roll of paper contained within the pillar head, the same being automatically stopped when the roll of paper has received its full complement of indications. The lecturer then briefly explained the self-indicating steelyard, which consisted of a heavily-laden poise carrying graduated dials, which were rotated by means of rack and pinion, the advantages of which are only too self-evident when used for weighing purposes, if extreme accuracy is essential. Mr. Davis then passed on to automatic action, and described the difficulties associated with the same, inasmuch as the controlling energy, slight as it may be, has invariably to be overcome by some point connected with the weighing mechanism, and in many instances by the beam direct. He then explained the hand and power machines known as Clawson's machines, and how this principle has lately been adopted in a machine for charging and wadding gun cartridges. Two machines were also exhibited and explained, one for automatically weighing grain, and the other for weighing flour, both the invention of a Mr. Richardson, and manufactured by Messrs. Averys. A discussion ensued, and some questions were asked and satisfactorily answered, at the conclusion of which a hearty vote of thanks was awarded to Mr. Davis for his interesting paper, which was suitably acknowledged by him.

Shipbuilding Notes.

On the 15th inst. there was launched from the shipbuilding yard of Messrs. Workman, Clark and Co. Limited, Belfast, a steel barquentine, built to the order of Messrs. Montgomerie and Workman, London. The dimensions are:—Length, 211ft.; breadth, 35ft.; depth, 17ft.; and gross tonnage, 960.

The "Danube," a steel screw steamer of about 6000 tons, built for the Royal Mail Steam Packet Company, was launched on the 16th inst. by Messrs. J. and G. Thomson Limited, Clydebank. Her length between perpendiculars is 420ft.; breadth, 52ft.; and depth (moulded), 35ft. 5ins. The engines are of the ordinary inverted direct-acting triple-expansion type, and steam is supplied by four large double-ended steel boilers.

There was launched on the 15th inst., from the yard of Messrs. C. S. Swan and Hunter, shipbuilders, Wallsend, an exceptionally large steel screw steamer. The vessel measures 435ft. in length, 53ft. in breadth, with a moulded depth of 34ft. She has been designed to maintain a speed of 11 knots when fully laden. Her engines have been built by the Wallsend Slipway and Engineering Company Limited, the cylinders being 31ins., 50ins., 80ins. diameter, by 54ins. stroke. Steam will be supplied by three double-ended boilers 16ft. 6ins. long by 13ft. 6ins. diameter, working at a pressure of 160lb.

The twin-screw steamer "Gaul," built by Messrs. Harland and Wolff, Belfast, for the Union Steamship Company's service to and from South Africa, was taken for a short trip at Southampton on the 13th inst. The dimensions are:—Length, 400ft.; breadth, 47ft.; depth, 31ft.; and gross tonnage, 4700 tons. She is propelled by two sets of triple-expansion engines having cylinders 18½ins., 30ins., and 50ins. diameter, and a stroke of 42ins. The engines developed 2200H.P., and on the run from Belfast and Cardiff to Southampton averaged over 12 knots. She is fitted with manganese bronze screws.

There was launched on the 17th inst., at the Caudan Yard, opposite Lorient, the French ironclad "Tréhouart." The dimensions are:—Length, 283ft. 9ins.; beam, 58ft. 5ins.; depth, 22ft. 10ins.; extreme draught, 24ft. 4ins. The displacement is 6590 tons, and there will be a pair of triple-expansion engines of 8400I.H.P., which are calculated to give, with forced draught, a speed of 16 knots. The armament will consist of two 11·8ins. guns mounted single in turrets on the line of the keel, eight 3·9ins. quick-firing guns mounted in broadside, four 3-pounder quick-firing, ten 1-pounder quick-firing, and two torpedo ejectors. The armour includes a complete belt, with a maximum thickness of 18ins., and a steel protective deck with 12½ins. turrets and 14½ins. revolving cupolas or turret covers.

Curve Resistances.

The question of curve resistances and of the means to adopt to reduce them to a minimum has been the object of numerous theoretical and experimental researches in various countries. But if we consider the results obtained, we shall find that they lack uniformity, and no reliable data can be deduced from the trials which have taken place from time to time on various railways.

To show that uniformity is wanting both in the results obtained and the rules adopted, we will simply remind our readers that the super-elevation is, in England, made proportional to the square of the speed, whilst in France it is taken as simply proportional to it.

That experiments on curve resistances give such varied results is attributable to the variable conditions under which the experiments or trials take place. The construction of the permanent way, and the manner it is kept in working order, play a great part. The direction of the wind and the hygrometric state of the atmosphere are factors which cannot be left out of consideration. It is not unusual to find the curve resistances increase by 100 per cent. during a journey. In some southern countries heavy summer storms are frequently preceded by fearful gales of wind, which, when they blow in a direction oblique to the motion of a train, retard its progress, and even stop it. The evil is aggravated on a curve, and super-elevation and widening of gauge are generally of no use under such circumstances.

In order to investigate the influence and mode of action of the various means and devices adopted to reduce curve resistance, the French Government (as we have already mentioned in a previous issue) undertook in November, 1890, extensive trials on the subject. These trials are not by any means completed; but the curious results at which the French engineers have arrived deserve special notice. It is a matter of regret that no such experiments are made in this country, for our railway engineers must certainly be aware of the unreliable character of the results obtained by previous experimenters.

The results of the recent French trials have been published in the bulletin of the Committee of the International Railway Congress, by Messrs. Lancrenon and Le Chatelier, engineers of the French State Railways. We will summarise them in these pages.

The trials have taken place on curves of various radii belonging to different lines. The least curve radius was one chain. French rolling stock was alone used. The main results have, however, been arrived at on a line specially built for the purpose near Paris. This experimental track is everywhere level, and comprises five curves of different radii and three tangents. The least radius is 328ft., and the largest 984ft. In the first series of trials the outer rails were not given any super-elevation. But in the following series super-elevations of 3½in. and 6¼in. full were successively adopted.

Previous experimenters have relied solely on the indications of a dynamometer attached to the drawbar of a special experimental car. This method is not free from objection, for it does not show the effects of acceleration or retardation in leaving or entering a curve. If a train enters a curve with a certain speed, the latter gets gradually reduced until a uniform velocity corresponding to dynamical equilibrium is attained. At that moment the pull of the engine is constantly equal to the resistances of the train, and the indications of the dynamometer can then be trusted. The precise moment when the uniform speed is attained is shown by an apparatus, the principle of which is very simple. It consists of a pendulum which is so contrived that when the train travels at a uniform speed it hangs vertically; but when the speed is accelerated or retarded by a decrease or increase of resistance, the pendulum oscillates one way or the other. The amplitude of the oscillation is proportional to the acceleration or retardation. The amount of the amplitudes is recorded automatically on a band of paper which moves uniformly below the pendulum. The speed of the train is recorded by means of electrical contacts located on the track at intervals of 32·8ft. To obtain the required data simultaneous observation of the pendulum and dynamometer is necessary.

The vehicles used in the trials were hauled by an engine the power of which was kept as constant as possible. Another method consisted in imparting a given speed to the vehicle, and then letting it run along until it stopped.

The deformations of the rails under the rolling vehicles were also measured.

Several types of locomotives were used in these trials, and most of them were fitted with special devices, which enabled one or both end axles to move laterally when entering a curve. Two bogie engines were also employed.

But here comes the most curious part of the results. With six and eight-wheel coupled goods engines having rigid wheel bases, the curve resistances are less than when one (or the two in eight-wheel engines) end or an intermediate axle is free to move endwise—that is, has a lateral play. The influence of super-elevation was well marked. At low speeds not exceeding 15 miles an hour, the engine resistance per ton on the curve with the higher super-elevation is frequently one-third, sometimes one-half, less than it was before any super-elevation was given. Bogies do not decrease curve resistance. The experiments show an opposite result.

It has been mentioned that French engineers had found that bogies increased curve resistances rather than reduced them. This is a strange result, opposed to our own experience; all the more so as the engine and carriage bogies adopted on French railways are of the same pattern as ours. This increase of resistance was explained by the fact that each bogie behaves as a separate four-wheel vehicle, with short wheel base; the tendency of the leading wheels to sheer the outer rails being in a great measure due to the shortness of the wheel base. This effect would be more marked in the case of bogies; but we can hardly realise this in the case of engines fitted with Adams' bogies, which allow a certain amount of transverse play on each side of the working pin, this play being checked by means of coiled or laminated springs, which keep the bogie steady on a straight track.

In carriage bogies, and those used in some engines in which no provision is made to give side play to the working pin, it may not be surprising to see the resistances increased while the train is travelling in a curve. The fixity of the working pin will certainly cause the outer leading wheel flange to bear against the outer rail, and the reason of this is plain. The distance between the bogie working pins is not indifferent, even if the bogie wheel base is such that it could alone run smoothly along the curve of minimum radius. The distance between the bogie working pins must be such that the path of their travel coincides as nearly as possible with the centre line of the curved track. To secure this result with every curve radius, one of the bogie pins should be capable of shifting transversely, so as to enable the bogie to set itself, so to speak, radially to the curve. This is the principle of the Bissel bogie, and also of the castor arrangement, if we look upon pony trucks and radial axles as bogies with only one axle. We cannot, therefore, admit the conclusions arrived at by the French engineers with regard to bogies.

Experiments were also made on the conicity of tyres. It appears, therefore, that the usual taper of 1 in 20 gives no better results than if the tyres were turned cylindrical. But it was found that a taper of 1 in 10 considerably reduced the resistances. This is very likely the case, for on some foreign railways having very sharp curves the taper is frequently made 1 in 16, with good results. Another interesting deduction is that the radius of the curve connecting the running surface of the tyre with its flange is not without influence on the resistance. The smaller this radius the smaller the resistance.

M. Le Chatelier has found that on curves of four and six chains, the resistances are the same at any speed not exceeding 18 and 25 miles an hour respectively. Beyond this, the resistances increase proportionally to the speed.

These experiments are not sufficiently conclusive, and further ones are to be made to ascertain in a definite manner the influence of these various elements. There has been and there is an important problem to solve in connection with new railways—namely, What combination of curves and gradients will give a uniform total resistance? The theoretical solution of this question is not particularly difficult, but its application to practical cases would be of no value, if not impossible. The influence of atmospheric changes on curve resistance is well marked. Damp weather may render the rails slippery; it may decrease locomotive adhesion; but it must be noted that, at the same time, the curve resistance decreases rapidly; in fact, the diminution of resistance is much greater than that of the adhesion. We are therefore driven to the conclusion that rules for the suitable combination of curves and gradients would be useless, as the local circumstances which are to guide engineers vary so much from one place to another.

Similar experiments took place also on a three-chain curve, and the results obtained by this first series of trials have been summed up as follows by M. Le Chatelier:—

1. All carriages and engines in use on French railways can run without difficulty in curves of 360ft., and even 246ft. radius, and the widening of the normal gauge, 4ft. 8½in. bare, is not necessary for this purpose.

2. The widening of gauge presents no advantages. It renders the motion of our vehicles unsteady, and increases resistance.

3. The insertion of a tangent between two curves of opposite curvature is only useful in this sense: that it enables the buffer springs to recover their previous equal compression; but this tangent need not be longer than 65ft.

4. Super-elevation can altogether be done away with without endangering the safety of trains even at high speeds. An exaggerated super-elevation increases the unsteady motion of vehicles by causing the trailing wheel flanges to bear hard against the inner rails.

5. The average curve resistance per ton of locomotives and vehicles of every description is 16lb. for a curve of five chains radius. In curves of 246ft.—3¾ chains—radius the mean resistance does not exceed 22lb.

We cannot admit the above results without a certain amount of reserve. They are so much in contradiction to the ideas, notions, and theories hitherto prevalent, that one will hesitate to consider them as definitive or decisive until another series of extended trials has taken place. It is desirable that other countries should undertake similar researches. — "Railway Press."

Notices of New Books.

A Manual of Machine Drawing and Design. By David Allan Low and Alfred William Bevis. London: Longmans, Green and Co. 7s. 6d.

If any fault can be found with the authors of this capital manual, it is in their selection of the title. Twenty pages out of a total of 370 are practically all that are given on machine drawing, and having this in mind we cannot help thinking that the title is apt to mislead. We do not, however, wish to imply that students of machine drawing will not find the study of a work of this kind of value. On the contrary, we are strongly of opinion that machine drawing and machine design ought to be studied simultaneously. But the work before us, although admirable in its way, will not supply a tithe of the information on machine drawing which the student will require to enable him to appreciate the contents of the major portion of the manual. To those who have already gained a knowledge of machine drawing, however, we cannot commend a better work than that which Messrs. Low and Bevis have prepared with such evident care.

Following the chapters on "Principles of Mechanics and Strength of Materials," we have a capital chapter on screws, bolts, and nuts, the subject being treated with a freshness which lends quite an additional interest to it; the same may also be said of the section on keys and cotters. Capital chapters are given on shafting and coupling and on supports for shafts, a number of dimensioned sketches of the latter being given. In the chapters which follow, on belt and rope gearing, the principal fault is the omission of any reference to centrifugal tension in these flexible transmitters of power. That this defect is a serious one may be seen from the effect it has upon the table of the power transmitted by ropes. Here it is expressly stated that the greatest stress on the rope is taken at 140lb. per square inch, and as the ratio of tensions is assumed to be 4, the driving force is 105 per square inch. The table gives the power transmitted by a 1in. rope at 5500ft. per minute as 13·75H.P.; but it is easy to show that at about this speed the whole of the allowable stress which is supposed to be available for driving force is required to resist the centrifugal tension, so that if the 105lb. limit of stress is not to be exceeded, the rope will be incapable of transmitting any power whatever. We trust this point will receive the attention it calls for in future editions of the work.

The subject of toothed gearing is well treated; but it is to be regretted that only about a dozen lines are given on worm gearing. In the following chapters, dealing with cranks and eccentrics, connecting rods, crossheads and guides, pistons and valves, etc., the authors appear to better advantage, and they are certainly to be congratulated upon the amount of data, dimensioned sketches, proportions, etc., which they have collected. A little more information on valve diagrams might, however, have been included with advantage. The chapters on riveted joints and steam boilers are well written, although some of the remarks are scarcely of the *fin-de-siècle* order—as for example, the statement that the usual working pressure in locomotive boilers is 140lb. The chapter on the steam engine does not call for any special mention; but in the concluding section of the work there are given complete working drawings of the engines of the "City of Paris."

Although we have dwelt upon one or two faults in this book, we are pleased to be able to commend it to the notice of our readers, and more especially to those who wish for a manual which, while giving the essential elements of machine design, avoids the use of the higher mathematics which render many excellent treatises of little use to the practical draughtsman and designer.

Trade Notes.

A new concern, to be known as the Ness Ironworks, was recently opened at Inverness.

The Glengarnock Iron and Steel Company, Scotland, have secured an order for steel girders for Sheffield.

The Stockton Malleable Iron Company Stockton, have just completed the rolling of a steel plate 75ft. long.

The directors of the Kelham Rolling Mills Company, Sheffield, recommend a dividend of 2s. 3d. per share.

At the annual meeting of the Parkgate Iron and Steel Company, held on the 17th inst., a dividend of 2 per cent. was declared.

Messrs. Hingley and Sons, of Dudley, have received an order from the Italian Minister of Marine for a quantity of chains and anchors.

The Electric Construction Corporation, London, are to supply the engines, dynamos, pumps, etc., for the electric-light station at Aberdeen.

Messrs. Addie and Co., colliery owners, Whifflet, have had a new washing plant laid down at their pit, capable of treating 500 tons of fuel per day.

Messrs. G. E. Bellis and Co., Ledsam-street Works, Birmingham, have received orders for 16 sets of engines for steam furnaces for the Admiralty.

The directors of Messrs. Dickson and Mann Limited, Bathville Steel Works, Annadale, recommend a dividend of 8 per cent. for the year ending March 31.

Messrs. John Brown and Co. Limited, Atlas Works, Sheffield, have contracted to supply the whole of the heavy armour for a battleship for the Spanish Government.

Messrs. Kincaid and Co., Greenock, have contracted to supply triple-expansion engines of 600H.P. for the 700-ton steel screw steamer to be built by Messrs. Murdoch and Murray, Port-Glasgow.

Messrs. Humphries and Co., London, are putting down plant at the Dawsholm Gasworks, Glasgow, in order that the corporation of that city may test the process of manufacturing gas from oil fuel.

Messrs. Vickers, Sons and Co. Limited, of the River Don Works, Sheffield, have received an order for a portion of the armour for the "Three Saints" battleship, to be constructed for the Russian Government.

The Scottish House-to-house Electric Supply Company have concluded a contract with the Brush Electrical Engineering Company Limited for the complete equipment of a central electricity supply station at Coatbridge.

Messrs. Samuel Osborne and Co., Clyde Steel and Iron Works, Sheffield, are now manufacturing rasps by machinery. The apparatus used is an American invention, of which Messrs. Osborne and Co. have acquired the sole rights in this country.

Dawson's New Speed Regulator.

DURING recent years the improvements effected in steam-engine governors have for the most part taken the form of auxiliary speed-regulating attachments, many of which have been applied to governors of ordinary construction with marked advantage. On the present occasion, however, we have pleasure in directing attention to a new form of steam-engine governor which is provided with a speed-regulating attachment, both being of somewhat novel design. From Fig. 1, which represents the governor at rest, it will be seen that in place of the usual balls two lengths of heavy chain are employed to furnish the requisite centrifugal energy. As will be perceived, the upper link of each chain is hung upon a crossbar, the latter being connected to the centre spindle, which is driven in the usual way by bevel wheels. To the lower ends of the two chains a heavy disc is attached, this being formed in one with the pipe or sleeve shown. This sleeve is grooved at the top to receive the friction rollers held by the forked lever, to which the valve rod is connected in the manner indicated.

Confining our attention for the moment to the parts already described, it will be evident that as the spindle and crossbar are rotated the chain will carry round the heavy disc, and as the speed of rotation is increased, the chain will, under the action of centrifugal force, take up a position somewhat similar to that shown in Fig. 2. But in doing this it will of course raise the disc and its attached sleeve, and operate the valve rod through the medium of the pivoted lever shown, in the usual manner.

The compensating attachment is carried by a vertical bracket bolted to the governor stand, as shown. The upper extremity of the vertical rod forms the fulcrum of the pivoted lever previously referred to, while the lower part of it is screwed for some distance, as indicated. The nut which works upon this screw takes the form of a flanged bush, and is carried by the lower arm of the bracket. Resting upon the flange of this bush is a bevel wheel, the latter being kept in contact with the flange by the short spiral spring shown. The short horizontal spindle carries at one end a bevel pinion, which gears with the bevel wheel, while upon the other extremity is mounted a leather-faced friction disc, which is driven by a double cone sleeve, forming part of the heavy disc of the governor. It should be mentioned that the friction disc is kept up to its work by a spiral spring, the strength of which can be readily adjusted by means of check nuts, as also can that of the spring on the vertical rod.

When the governor is running at its normal speed the double cone just runs clear of the friction disc; but if a slight increase of speed occurs, the governor rises, one side of the cone engages with the disc, and by means of the bevel gear the nut is turned and the vertical rod raised, thus reducing the steam supply. The reverse action takes place when the governor falls owing to diminished speed, as the nut turns in the opposite direction and lowers the rod. It will thus be seen that the effect of the compensating gear is to allow the governor to revolve in one plane, and therefore at a uniform speed. It will be understood that in the event of a sudden alteration of the load the governor itself would respond to regulate the steam supply, and for the time being the friction disc would be pushed back by the rising of the cone; but the spring provided maintains the two surfaces in contact, and the compensator rod is speedily elevated, thus allowing the governor to resume its normal position. It should be pointed out that the movement of the rod in a downward direction is limited by a collar upon it, which comes in contact with the upper arm of the bracket. If the governor continues to rotate, the bevel wheel slips over the surface of the flanged bush previously mentioned. The position of the friction disc with relation to the double cone can be readily adjusted, while by changing the points of suspension of the chain the governor can be adapted to various speeds.

It is claimed that the method of suspending the upper and lower links reduces friction considerably, and that generally the chain is very mobile and responds readily to any speed variation, while at the same time it prevents any tendency to "hunt." We recently inspected the governor at work on a McNaught beam engine of 950I.H.P. in a cotton mill at Mossley, where it was evidently giving the greatest satisfaction. As illustrating the rapidity with which the governor acts, it may be stated that recently a shaft broke in the mill, throwing off about 450H.P. without any appreciable difference in the speed of the engine being observed. As will be seen, the arrangement is very ingenious, and it certainly does not appear to be lacking in effectiveness. Mr. Seth Dawson, Ryecroft Ironworks, Ashton-under-Lyne, the patentee and maker, who has long made engine governing a speciality, will be pleased to supplement the information given above, upon application.

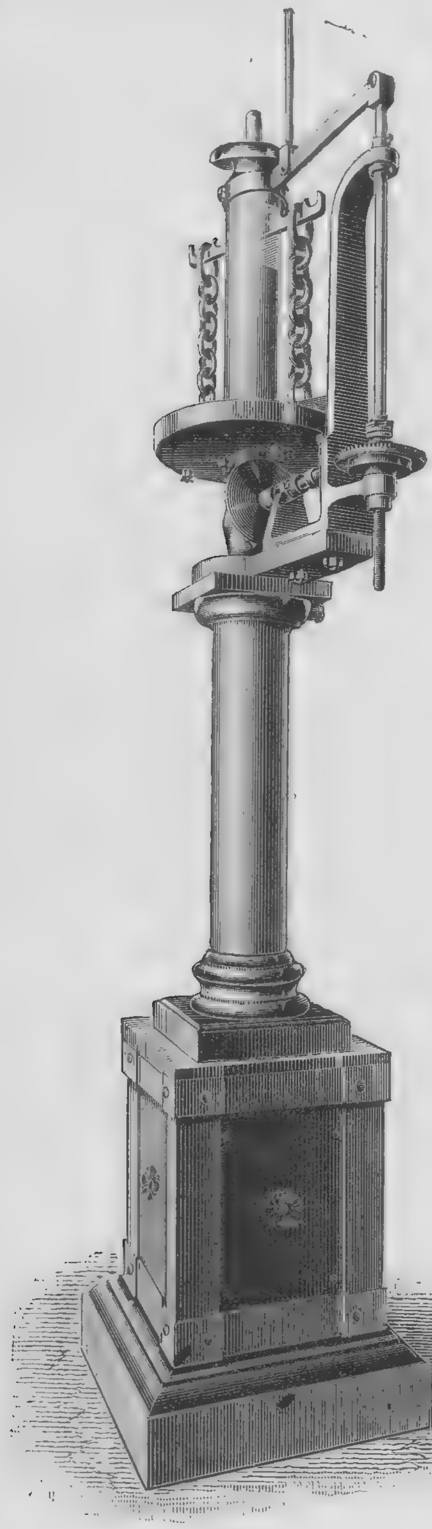


FIG. 1.

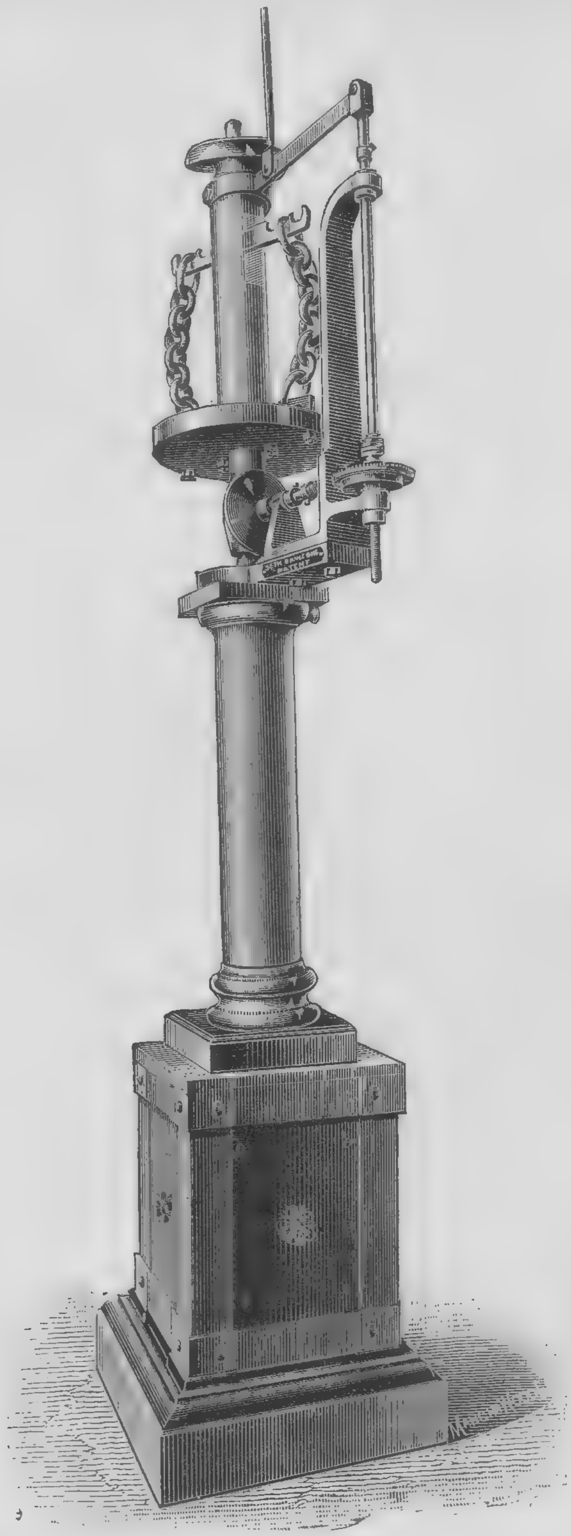


FIG. 2.

DAWSON'S NEW SPEED REGULATOR.

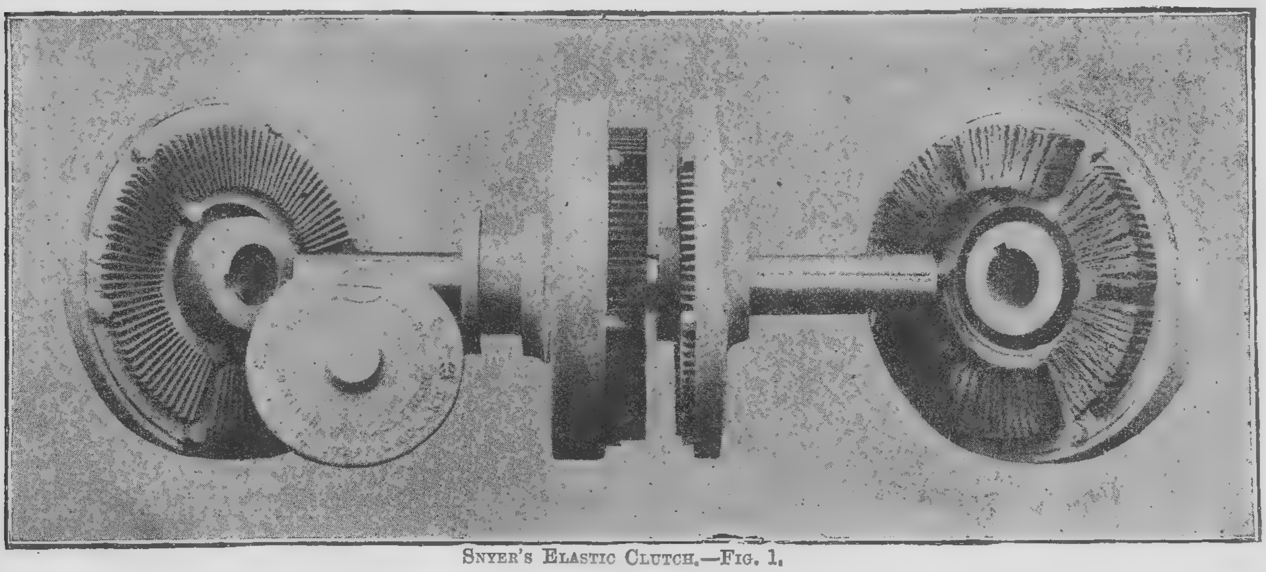
Liquid Air.

THE greater part of Professor Dewar's lecture at the Royal Institution, London, on May 11, was devoted to the subject of liquid air. In opening, however, the Professor reverted to the subject of selective absorption, with which he closed his remarks on the previous Thursday. Again declaring oxygen to be the agent in selective absorption, he said that that was an important factor in the motion of the atmosphere and in temperature. Stopping to speak of the absorption of heat, he showed how differently that might be affected by the agency of glass, rock salt, or a thin film of water. Then he asked what would take place at the limits of the atmosphere provided we could lower our temperature to that of celestial space. There had been various theories of the limit of temperature, and the result of investigation since 1845 was that they were able to go to 200° minus. At 200° minus all bodies were liquefiable except hydrogen. To get to that temperature, the point was, in a highly vacuous vessel, to prevent absorption or radiation. By such means he had obtained three flasks of oxygen in as many states of liquefaction. Experimenting with these he demonstrated the blue colour of oxygen, then that oxygen boils constantly at an exceedingly low temperature, and that that temperature is not only low, but steady. Experimenting next with liquid oxygen and alcohol, he ran some drops of alcohol into the liquid oxygen. This was with the object of showing (and the experiment was in every way successful) that in a few minutes these drops would part with their heat to the oxygen, and, having done this, would solidify, so that they might be rattled against the interior of the glass flask like marbles. At that point the alcohol was at such a low temperature that it could not be set on fire. It solidified at a temperature of about 130° minus. The experiment which followed was equally interesting. It consisted in taking a few drops of the liquid oxygen and placing them on an ordinary piece of glass. The result was that the drops at once bubbled, or rotated, as drops of pure water when put on a red-hot plate, the cause in each case being the difference of temperature. A further experiment—this time with an electric current—brought him to the important conclusion that as the zero of temperature was approached chemical action diminished. Then he pressed the inquiry further—Did this liquid absorb in the same manner as did gas? He had previously shown by the spectrum the absorbent power of oxygen as a gas, and in the same way he now demonstrated that in its liquid state oxygen carried the same character of selective absorption. Next he demonstrated that liquid oxygen is highly magnetic, the attraction of the pole for a sponge saturated with this oxygen being shown on the screen with amusing effect. Coming to the question of the direct production of liquid air, he said that oxygen is more easily liquefiable than air, this being due to the fact that its critical point is higher than air. Oxygen, for instance, was readily liquefied at 113° minus, while nitrogen liquefied at 140° minus. Taking some liquid oxygen at the temperature named, he put it in a small vessel in a tumbler and boiled it down to 200° minus. The result was that the air in the tumbler could not continue to exist as air, but gradually formed into globules and dropped, just as steam might on cooling. Quite as easily he made air synthetically, his method here being to take a quantity of liquid nitrogen and apply to it a fifth of its volume of oxygen. The liquid air thus made could not be distinguished from the liquid air made in the ordinary way. Two other experiments brought the series of lectures to a close. One showed the effect of low temperature in revealing whether or not a vacuous space, or what was believed to be a vacuous space, contained vapour. The other was to demonstrate that at 180° minus a sphere of oxygen had a sufficient transparency to heat to allow rays to pass through and burn a piece of brown paper.

ELECTRIC TRACTION will be adopted on the underground railway at Baltimore. The trains to be hauled are very heavy, as it was originally intended to work the line with steam locomotives, but, to secure better ventilation, it has been decided to adopt electricity. The electric locomotives weigh ninety tons each, and are carried on twelve wheels.

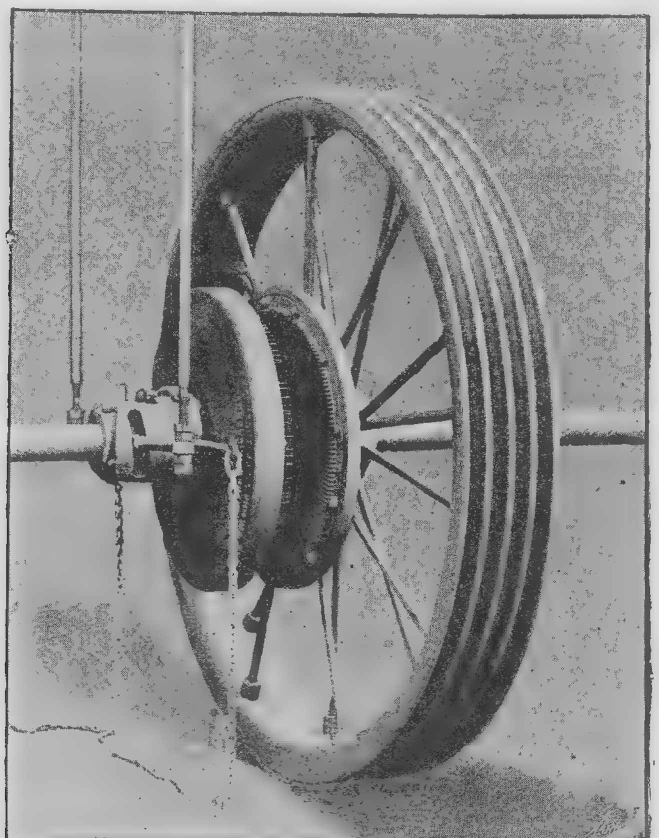
Snyer's Elastic Clutch or Coupling.

THE clutch or coupling which we illustrate herewith consists of two parts, one of which carries a number of brushes made of flat steel wire, while upon the other are secured a series of finely-serrated or toothed plates. Motion is transmitted by the engagement of the two parts of the clutch, and in such a manner that when in motion no slipping occurs, although there is a certain amount of elasticity in the connection, which for many purposes is of great advantage. Of the appended illustrations, Fig. 1 shows a pair of clutches arranged for a shaft coupling, while Fig. 2 is from a photograph of a 50H.P. clutch and rope pulley which is employed to transmit power from a gas engine.



SNYER'S ELASTIC CLUTCH.—FIG. 1.

With clutches of this description stopping or starting of high-speed machinery can be readily effected without shocks and without slowing down the engine. As an instance of this, we may mention that the two clutches, of 250H.P. each, running at 200 revolutions per minute, which transmit power to the dynamos which light up the whole of Messrs. Cockerill's (Seraing) Works, are started with the engine at full speed, the clutches slipping for about five seconds, when they bring the large dynamos up to full speed.



SNYER'S ELA TIC CLUTCH.—FIG. 2.

Among other advantages claimed for the device is the diminution of the wear and tear of machinery, belting, etc., and immunity from breakdown, owing to the elasticity of driving and to the clutches being made only slightly in excess of the power specified, which allows of the clutch slipping if any considerable additional strain is thrown upon it, thus limiting and measuring the amount of power transmitted. We may add that over three years' use has not developed any signs of undue wear, and also that considerably over 12,000H.P. of these clutches are now in successful operation, chiefly on the Continent. Messrs. Cowlishaw, Walker and Co., Etruria, Staffordshire, are the makers.

Investigation of the Strength of Gear Teeth.*

To mechanical engineers, the strength of gear teeth is a question of constant recurrence, and although the problem to be solved is quite elementary in character, probably no other question could be raised upon which such a diversity of opinion exists, and in support of which such an array of rules and authorities might be quoted. In 1879, Mr. John H. Cooper, the author of a well-known work on "Belting," made an examination of the subject, and found there were then in existence about 48 well-established rules for horse-power and working strength, sanctioned by some 24 authorities, and differing from each other, in extreme cases, about 500 per cent. Since then a number of new rules have been added; but, as no rules have been given which take account of the actual tooth forms in common use, and as no attempt has been made to include in any formula the working stress on the material, so that the engineer may see at once upon what assumption a given result is based, I trust I may be pardoned for suggesting that a further investigation is necessary or desirable.

In summing up his examination, Mr. Cooper selected the following formula from an English rule published at Newcastle-under-Lyme in 1868, and, as an expression of good general averages, it may be considered passably correct.

$X = 2000\,p f$ ....(1)

in which

X = breaking load of tooth in pounds.
p pitch of teeth in inches.
f = face of teeth in inches.

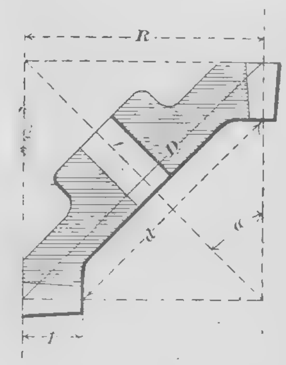
In conclusion he makes this pertinent observation:—"It must be admitted that the shape of the tooth has something to do with its strength, and yet no allowance appears to have been made by the rules tabulated above for such distribution of metal, the breaking strength being based upon the pitch or thickness of the teeth at the pitch line or circle, as if the thickness at the root of the tooth were the same in all cases as it is at the pitch line." Notwithstanding the fact that the necessity for considering the form of the tooth, as well as its pitch and face, was thus clearly set forth over thirteen years ago, I am not aware that anyone else has taken the trouble to do it; and, as the results to be presented have been well tested by experience in the company with which I am connected, I believe they will be of interest and value to others.

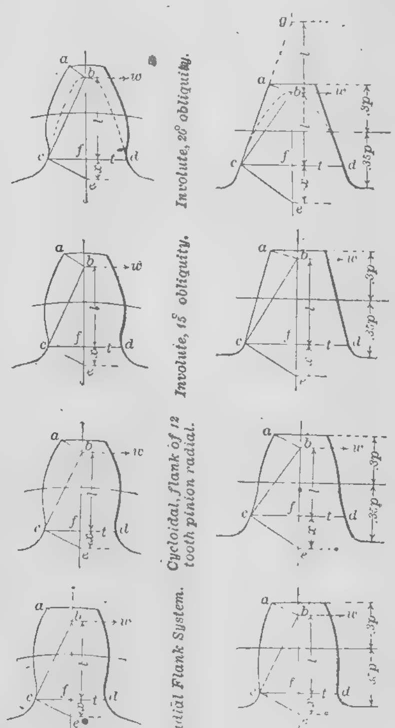
In estimating the strength of teeth, the first question to be considered is the point or line at which the load may be applied to produce the greatest bending stress. In the rules referred to, the load is sometimes assumed to be applied at the pitch line, sometimes at the end of the tooth, and sometimes at one corner; but in good modern machinery—the agricultural type excepted—there is seldom any occasion to assume that the load is not fairly distributed across the teeth. Of course, it may be concentrated at one corner, as the result of careless alignment or defective design, in which the shafts are too light or improperly supported, and, for a rough class of work, allowance should certainly be made for this contingency; but in all cases where a reasonable amount of care is exercised in fitting, a full bearing across the teeth will soon be attained in service. It must be admitted, however, that on account of the inevitable yielding of shafts and bearings, even of the stiffest construction, the distribution of pressure may not be uniform under variable loads, and that the assumption of uniform pressure across the teeth is not always realised in the best practice. To what extent it is realised I shall not attempt to estimate, but in general practice, where the width of the teeth is not more than two or three times the pitch, the departure cannot be regarded as serious. The conclusion is therefore reached that in first-class machinery, for which the present investigation is intended, the load can be more properly taken as well distributed across the tooth than as concentrated at one corner. Having thus disposed of the first question, the second is, At what part of the face should the load be assumed to be carried in estimating the strength of a tooth?

Evidently the load may be carried at any point within the arc of action, and it might be argued that when a tooth is loaded at its end there are always two teeth in gear, and that the load should be divided between them. This is theoretically true of all teeth properly formed and spaced, but it must be admitted that mechanical perfection in forming and spacing has not yet been reached, and that the slightest deviation in either respect is sufficient to concentrate the whole load at the end of a single tooth. In time this concentration may be relieved by wear, but it is not so easily corrected as unequal distribution across the teeth; and, as the present practice of cutting gears with a limited number of equi-distant cutters makes it almost impossible to obtain teeth of proper shape, it is evident that the load cannot safely be assumed as concentrated at a maximum distance less than the extreme end of the tooth. In some cases, of course, the teeth will not be so severely tested, and the error in this assumption compensates in a measure for the error in the first assumption of equal distribution across the teeth. Having thus concluded that gear teeth may fairly be considered as cantilevers loaded at the end, the influence of their form upon their strength remains to be disposed of.

In interchangeable gearing, the cycloidal is probably the most common form in general use, but a strong reaction in favour of the involute system is now in progress, and I believe an involute tooth of 22½° obliquity will finally supplant all other forms. There are many good reasons why such a system should be generally adopted; but it is not my purpose at present to discuss the merits and defects of different systems of interchangeable gearing, and I now propose to explain how the factors given in the table herewith were determined by graphical construction.

A number of figures were carefully drawn on a large scale, to represent the teeth cut by a complete set of equi-distant cutters, making the fillets at the root as large as possible to clear an engaging rack.





12 tooth pinions. Racks.

The addendum was $0{\cdot}3\,p$, and root $0{\cdot}35p$, as shown in the illustrations, and the clearance $0{\cdot}02\,p$.

When the load is applied at the end of a tooth and normal to its face in the direction $a\,b$, it may be resolved into two forces—one tending to crush the tooth, and the other to break it across. The radial component which tends to crush the tooth directly has but a slight effect upon its strength. In material which is stronger in compression than in tension, the transverse stress due to the other component, W, is partially counteracted on the tension side, and the teeth are stronger by reason of their obliquity of action; but in material which is weaker in compression the reverse is the case, and, in general, it may be said that the strength of the teeth will not be affected more than 10 per cent. either way by the consideration of this radial component.

It should therefore be understood that, for the sake of simplicity, the factors given have been determined only with reference to the transverse stress induced by the force W, which may be regarded as the working load transmitted by the teeth. This load is applied at the point b, but it does not at once appear where the tooth is weakest; and, to determine that point,

* Paper read before the Engineers' Club of Philadelphia.

advantage is taken of the fact that any parabola in the axis $b\ e$ and tangent to b W at the point b encloses a beam of uniform strength. Of all the parabolas that may thus be drawn, one will be tangent to the tooth form, and it is evident that the point of tangency will indicate the weakest section of the tooth. In the rack tooth of 20° obliquity, this is found at once by prolonging $c\ a$ to its intersection g with the centre line $f\ b$, and laying off $b\,f = b\,g$; and in other cases the weakest section $c\ d$ may be found, tentatively, to a nice degree of accuracy in two or three trials. Having found the weakest section, the strength at that point is also determined graphically by drawing $b\ c$ and erecting the perpendicular $c\ e$ to intersect the centre line in e; $e\,f$ or x is then taken to measure the strength of the various forms of teeth.

TABLE I.

Number of Teeth.	Factor for Strength, y. Involute 20° Obliquity.	Involute 15° and Cycloidal.	Radial Flanks.
12	0·078	0·067	0·052
13	0·083	0·070	0·053
14	0·088	0·072	0·054
15	0·092	0·075	0·055
16	0·094	0·077	0·056
17	0 096	0·080	0·057
18	0·098	0·083	0·058
19	0·100	0·087	0·059
20	0·102	0·090	0·060
21	0·104	0·092	0·061
23	0·106	0·094	0·062
25	0·108	0·097	0·063
27	0·111	0·100	0·064
30	0·114	0·102	0 065
34	0·118	0·104	0·066
38	0·122	0·107	0·067
43	0·126	0·110	0·068
50	0 130	0·112	0·069
60	0·134	0·114	0·070
75	0·138	0·116	0·071
100	0·142	0·118	0·072
150	0·146	0·120	0·073
300	0·150	0·122	0·074
Rack.	0·154	0·124	0·075

TABLE II.—SAFE WORKING STRESS S., FOR DIFFERENT SPEEDS.

Speed of Teeth in Feet per Minute.	100 or less	200	300	600
Cast iron ..	8,000	6,000	4.800	4,000
Steel........	20,000	15,000	12,000	10,000

Speed of Teeth in Feet per Minute.	900	1200	1800	2400
Cast iron ..	3000	2400	2000	1700
Steel	7500	6000	5000	4300

To understand the reason for this construction and the actual relation which the distance x bears to the strength of the tooth, it will be observed that the bending moment W l on the section $c\ d$ is resisted by the fibre stress s into one-sixth of the face f times the square of the thickness t, or by the well-known formula for beams we have

$$W\,l = \frac{s\,f\,t^2}{6}, \text{ or}$$

$$W = \frac{s\,f\,t^2}{6\,l} \quad \text{.................(1)}$$

But by similar triangles

$$x = \frac{t^2}{4\,l} \quad \text{....................... (2)}$$

and substituting this value in equation (1) we have

$$W = s\,f\,\frac{2\,x}{3} \quad \text{...............(3)}$$

or we may write

$$W = s\,p\,f\,\frac{2x}{3p} \quad \text{.................(4)}$$

$\frac{2x}{3p}$ or y is the factor determined by graphical construction and given in Table I. for convenient reference. This is multiplied by the pitch face and fibre stress allowable in any case when the working load W is to be determined. What fibre stress is allowable under different circumstances and conditions cannot be definitely settled at present, nor is it probable that any conclusions will be acceptable to engineers unless based upon carefully-made experiments. In the article referred to, certain factors are given as applicable to certain speeds; and in the absence of any later or better light upon the subject, Table II. has been constructed to embody in convenient form the values recommended. It cannot be doubted that slow speeds admit of higher working stresses than high speeds, but it may be questioned whether teeth running at 100ft. a minute are twice as strong as at 600ft. a minute, or four times as strong as the same teeth at 1800ft. a minute. For teeth which are perfectly formed and spaced, it is difficult to see how there can be a greater difference in strength than the well-known difference occasioned by a live load or a dead load, or two to one in extreme cases. But for teeth where noise is sometimes produced in running, it should be said that this table is submitted for criticism rather than for general adoption. It is one which has given good results for a number of years in machine design, and its faults, such as they may be, are believed to be in the right direction from another point of view; for, when the durability of a train of gearing is considered, it would seem that all gears in the train should have the same pitch and face, because all transmit the same power, and are therefore subject to the same wear. But this argument is modified by the further consideration that equal wear does not mean equal life in a train of gearing, and a compromise between the considerations of life and strength must result in the adoption of values for different speeds somewhat similar to those given in Table II.

To illustrate the use of Tables I. and II., let it be required to find the working strength of a 12-toothed pinion of 1in. pitch, 2½in. face, driving a wheel of 60 teeth at 100ft. or less per minute, and let the teeth be of the 20° involute form. In the formula $W = s\,p\,f\,y$, we have for a cast-iron pinion—

$s = 8000$, $p\,f = 2{\cdot}5$, and $y = 0{\cdot}078$,

and multiplying these values together we have W=1560lb. For the wheel we have $y = 0{\cdot}134$, and W=2680lb.

The cast-iron pinion is, therefore, the measure of strength; but if a steel pinion be substituted, we have s = 20,000 and W = 3900lb., in which combination the wheel is the weaker, and it therefore becomes the measure of strength. In teeth of the involute and cycloidal forms, there is a marked difference between racks and pinions in working strength, while in radial flanked teeth, which are used more especially on bevel gears, the difference is not so pronounced. These teeth are to be found in the great majority of all cut bevels, because they can be more cheaply produced on milling machines and gear cutters; but the 15° involute bevel tooth, as made by the Bilgram process, is superior in accuracy of form and finish, and is often preferred for patterns and fine machinery. There are, therefore, two well-defined forms of bevel gears to be considered; and to bring the strength of bevel gearing within the scope of the present investigation, it will be necessary to understand how the variation in their pitch and radius of action is allowed for, and without going into a demonstration of the formula, its simple statement will probably be sufficient.

Referring to the figure,
D = large diameter of bevel.
d = small diameter of bevel.
p = pitch at large diameter.
n = actual number of teeth.
N = formative number of teeth.
n = secant a, or the number corresponding to radius R.
f = face of bevel.
y = factor depending upon shape of teeth and formative number N.
W = working load on teeth referred to in diagram D.

Then it can be shown that

$$W = s\,p\,f\,y\,\frac{D^3 - d^3}{3\,D^2\,(D - d)} \quad \text{.........(5)}$$

To illustrate the use of this formula, let it be required to find the working strength of a pair of cast-iron mitre gears of 50 teeth, 2in. pitch, 5in. face, at 120 revolutions per minute.

In this case, $a = 45°$, $C = 31{\cdot}8$, $d = 24{\cdot}8$, and secant $a = 1{\cdot}4$, $N = 50 \times 1{\cdot}4 = 70$, for which $y = 0{\cdot}071$. The speed of the teeth is 1000ft. per minute, for which, by interpolation in the table, $s = 2800$, and the formula becomes by substituting these values:—

$$W = 2800 \times 2 \times 5 \times 0{\cdot}071 \times \frac{31{\cdot}8^3 - 24{\cdot}8^3}{3 \times 31{\cdot}8^2\,(31{\cdot}8 - 24{\cdot}8)}$$

$$= 1988 \times 0{\cdot}795 = 1580\text{lb.}$$

This result is attained by some labour which is practically unnecessary, because d should never be made less than $\frac{2}{3}$ D, and when this rule is observed, the approximate formula,

$$W = s\,p\,f\,y\,\frac{d}{D} \quad \text{...........(6)}$$

gives almost identical results. The reason for fixing a limit to the ratio $\frac{d}{D}$ is found in the fact that a further increase in face adds very slowly to the strength and increases very rapidly the difficulty of properly distributing the pressure transmitted. Where long-faced bevels are used, the teeth near the shaft are generally broken by improper fitting, or, when properly fitted, by the spring of the shaft or the yielding of its bearings, and as the limit imposed gives about 70 per cent. of the strength attainable by extending the face to the centre, it is thought to be as liberal as experience can justify.

In presenting certain forms and proportions for teeth, on which Table I. is founded, I am aware that other forms and proportions are in common use which have some claims to recognition, but my chief object at present is to show that the strength of gearing can be reduced to a rational basis of comparison on which all authorities may ultimately unite.

The Use of Feed-water Heaters in Rolling Mills.

In the manufacture of all classes of mill and factory products the cost of the "raw material" is a more or less important item, varying, of course, in different lines, but in all very properly given a large share of attention in the management of the enterprise.

There is one item, however, which, so far as its relation to finished mill products is concerned, may be called "raw material," the cost of which receives comparatively little attention, and that is mechanical energy, or, as it is usually briefly termed, "power." Most manufacturers know, in a general way, what the power used costs per year; but few give the matter sufficient attention to see that that power is obtained at the least possible net cost. This is something outside the province of the purchasing agent, and it is because it is so, or because "power" is something not bought in the open market, or having a definite market quotation per unit, that its most economical production receives such a minor share of attention.

A far greater quantity of heat must be added to a given quantity of water to raise it 1° in temperature between the freezing and boiling points — 32° and 212° F. — than is required to raise the same quantity of water 1° in temperature at 212°, the point where steam is formed at atmospheric pressure, which is the theoretical pressure of steam in the exhaust pipe of an engine, and unless advantage be taken of this exhaust steam to heat the feed-water this heat is lost. The saving which is effected, or the increased evaporation from 1lb. of coal burned, is shown with exactness in the table below:—

The foregoing remarks have referred to the use of heaters only without regard to their form of construction, simply treating of results obtainable, not the means. Some of the more important points to be considered in the selection of feed-water heaters will now be discussed.

Feed-water heaters are divided into two general types, known as "open" and "closed." In the first-named class the exhaust steam is brought into direct contact with the cold feed-water, and is condensed therein, and in such condensation gives up its heat to the water, raising the temperature of the latter to at or near the boiling point. In heaters of the second class, the "closed" type, the exhaust steam is kept separated from the cold water by thin metal partitions, the water being passed through tubes surrounded by steam, or *vice versa*, the heat being transmitted to the water through the walls of the tubes.

Open heaters, while theoretically the most efficient, are not to be commended in practice, owing to the fact that the exhaust steam carries with it in a finely-comminuted state the oil which has been used for cylinder lubrication, and in the condensation which takes place this oil is intimately

PERCENTAGE OF FUEL SAVED BY HEATING FEED-WATER.
(Steam Pressure, 60lb.)

Initial Temperature of Water entering Heater.	Heat Units Absorbed in Generating Steam.	Temperature of Water Entering Boiler. 120°	140°	160°	180°	200°	202°	204°	206°	208°	210°	212°
32°	1175	7·49	9·19	10·89	12·59	14·30	14·47	14·64	14·81	14·98	15·15	15·32
40	1167	6·86	8·57	10·28	12·00	13·71	13·88	14·05	14·22	14·40	14·57	14·74
50	1157	6·05	7·78	9·51	11·24	12·97	13·14	13·32	13·49	13·66	13·83	14·00
60	1147	5·23	6·97	8·72	10·46	12·21	12 38	12·55	12·73	12 90	13 08	13·25
70	1137	4·41	6·16	7·91	9·67	11·43	11·61	11·78	11·96	12·14	12·31	12·49
80	1127	3·44	5 32	7·10	8·87	10·65	10·82	11·00	11·18	11·36	11 53	11·71
90	1117	2·68	4·47	6·26	8·06	9 85	10 03	10·21	10·38	10·56	10 74	10·92
100	1107	1·80	3·61	5·42	7·23	9·03	9·21	9·39	9·57	9·75	9·93	10 11
110	1097	0·91	2·74	4·55	6 38	8·20	8·38	8·56	8·74	8·93	9·11	9·29
120	1087	—	1·84	3·67	5·51	7·35	7·54	7 77	7·90	8·09	8·27	8·45

Accurately speaking, steam power is a manufactured product, the raw material therefor being fuel and water, and the plant required in its production, boilers and engines, and the same care should be used to secure a given amount of mechanical energy from a minimum quantity of fuel and water with the least wear and tear on plant that is given to secure a given weight of finished mill product, structural material for instance—from the least amount of pig iron—and the fewest breakdowns of roll-trains. With this in view, in rolling mill practice the bye or waste products, mill cinder and crop ends, are saved and turned to some account. In steam-power production and use there is what may be called a "crop end," which in many instances goes entirely to waste—that is, exhaust steam. As in most cases practised, the steam, after having done its work in a more or less imperfect engine, where it has had none too good an opportunity to render a favourable account of itself, is allowed to escape directly into the atmosphere at a temperature approximately at the boiling point of 212° F., and carrying with it a quantity of heat which may be, and can be in a very large measure, utilised through the use of proper appliances, feed-water heaters.

These appliances, through which the heat being carried off in exhaust steam is transmitted to the feed-water entering the boiler, effect a saving in two ways—first, by raising the temperature of the feed-water, the same boiler may safely be made to generate more steam (the temperature of the water being at or near the boiling point when it enters the boiler), thus saving in investment for a required capacity of power plant, or for a given amount of fuel burned, making a greater output of available power; second, by avoiding the introduction of cold water into the boiler, making the temperature at the different places in the boiler more nearly equable, thus preventing strains from unequal expansion, lessening repair bills, and prolonging the life of the boiler.

mixed with the feed-water and passes to the boiler, there, with other materials present in nearly all waters, forming troublesome scale, and causing bags or blisters in the sheets. These disadvantages render the boiler less efficient in service, and cause larger bills for repairs, if not through neglect inducing explosions, and more than offset any advantages this class of heaters might have in heating capacity alone. In some heaters of the open type, devices for skimming or mechanically separating this oil from the water are used, but their efficiency is doubtful. The oil, it will be borne in mind, has entered the heater with the exhaust steam in an extremely finely-divided state, and at the temperature the feed-water leaving the heater *should* be—200° to 212° F.—a very large portion of this oil will be mixed with the water as an emulsion, beyond the reach of any mechanical device to completely separate it. The experience of the boiler inspection and insurance companies covering every type of heater, and with all kinds of boilers, bears out this point strongly.

In "closed" heaters the exhaust steam and the water are kept entirely separate, the heat being transmitted to the water through the walls of tubes, and the water of condensation allowed to run to waste. In heaters of this class the trouble due to oil entering the boiler is avoided, but some closed heaters from their design may be no more commercially efficient than the faulty open heaters above referred to. Some of the matters to keep in view in selecting a feed-water heater are enumerated below.

Look with suspicion upon claims that feed-water can be heated to above 212° F. Not but that in some heaters feed-water can be heated to above the boiling point, even in some cases perhaps to 216°; but such is the reverse of economical performance, owing to the fact that it comes from restricting the exhaust and creating back pressure in the engine cylinder. With an engine exhausting at atmospheric pressure the temperature of the exhaust steam is not above 212°, and steam at this

temperature cannot raise the temperature of water to any higher point. Heat of itself never passes from a colder body to a hotter one. However, the fact that the water is heated to above 212° is not conclusive evidence that the heater is causing back pressure from insufficient area of exhaust steam passage; the same effect may be produced by leaky valves in the engine. On the other hand, leaky valves, through their admission of live steam into the exhaust, may very considerably help the performance of a heater otherwise inadequate to the work put upon it. To judge accurately of the performance of a heater, before it is connected the valves should be found to be in perfect order by indicator test of the engine. Otherwise a badly-designed heater may show high heating efficiency and a properly-designed heater poor results without showing any corresponding change in coal bills. To ensure absolutely free exhaust through the heater and provide sufficient space for the exhaust steam to do its work effectively, the net sectional area of the steam space in the heater should be largely in excess of the area of the exhaust pipe from the engine.

It is also of importance that the heater have a settling chamber of ample dimensions. While it is not the province of a heater working on exhaust steam to take the place of a feed-water purifier working on live steam—to remove scale-making material from the water,—yet much matter merely held in suspension can be collected if settling chambers of sufficient dimensions be provided, and the heater be of sufficient size for the work that the water may not need to be forced through with too great rapidity. Such provision need not impair the efficiency of the heater, and it does very considerably add to the efficiency of the boiler.

The heater itself should be easily cleaned. Not only the passages for the water, but for the steam, should be accessible for cleaning. In heaters where the steam passes through tubes surrounded by water, provision should be made for cleaning the tubes of any oil which may collect in them, and for cleaning the outside of the tubes of any sediment from the water. A very slight coating of sediment on the surface of a tube may very materially affect its conductivity of heat.

Ample provision should be made for expansion. Without this there will be annoying leaks in a very short time after the heater is put into service. And if, in addition to provision for expansion, the heater be so designed that the pressure—for it must be remembered that the chamber in which the water is heated is under the same pressure as the boiler—tends to tighten the tubes instead of loosening them, as the tendency is in some heaters, the liability of leakage will be greatly reduced. Of material of which heaters are constructed, cast iron and brass, on account of their incorrodibility, are preferable, provided they are of sufficient strength to withstand the pressure. The fatty acids from the cylinder oil have a tendency to pit and corrode wrought-iron and steel shells. Copper tubes, in iron or steel shells, are not to be recommended, owing to the galvanic action which is set up, and which shortens the life of both tubes and shell.

From what has been said it will be seen that there are heaters and heaters. Some have good points, some bad, but there are few which, if properly installed, and of sufficient size for the work to be performed, will not show a marked economy in the use of fuel. It is difficult to impress upon steam users the importance of fuel economy with coal at 1·50dol. per ton, but the facts set forth above should, in these times of close competition and general adoption of devices looking to lessened cost of production, receive more than passing notice. Exhaust steam in the quantities made in rolling mills and steel works is too valuable a "crop end" to be allowed to go to waste, as it usually does.—"American Manufacturer."

Metal Trade Memoranda.

A rich discovery of iron ore has been made at Wairapara, in the south of the North Island, New Zealand.

The Distington Hematite Iron Company, Whitehaven, will blow in an additional blast furnace in the course of the next few days.

The total stocks of copper on the 31st of January were 58,507 tons, and on the 15th inst. 50,289 tons, so that in the three and a half months there has been a decrease of 8218 tons.

Iron and steel during the first four months of the current year were shipped to the extent of 861,835 tons, of £6,881,846 value, as compared with 823,486 tons, of £7,126,633 value, in the corresponding period of 1892, and 981,861 tons, of £9,089,839 value, in the first four months of 1891.

The total output of gold from the Witwatersrandt Mines, South Africa, during April amounted to 112,053oz., as compared with 114,474oz. in the previous month, and of 95,500oz. in April last.

Mr. Turner, a retired Indian civilian, applied to the Madras Government last year for a concession to explore and work the chrome mines which are to be found in the Salem and Trichinopoly districts. It is under contemplation to grant the concession asked for by Mr. Turner, so far as the same may be in accordance with the Imperial and prospecting rules.

A new process for recovering scrap iron from tinplate clippings has been devised by M. Lambotte, of Brussels. The clippings are introduced into a vertical cylindrical furnace, which is surrounded by a spiral. Air charged with chlorine gas passes through the spiral, where it is heated, and, entering the furnace below, passes through the clippings. The tin is attacked and stannic chloride is formed, which volatilises, and is subsequently collected upon condensing surfaces moistened with a solution of the same chloride. The iron is not attacked, and when entirely cleaned from tin is removed from below, and again used.

New Companies.

Cryer Metal Syndicate Limited.—This company was registered on the 17th inst., with a capital of £1000, in £5 shares, to purchase the interest of Messrs. Wm. Gilchrist and Wm. Cryer in a provisional specification (No. 5632), for protecting an invention of a new process for converting iron into a substance having the properties of steel. The rules of Table A mainly apply. Registered by Marshall and Haslip, 6, Martin's-lane, E.C.

Bourne and Grant Electricity Supply Company Limited.—This company was registered on the 13th inst., with a capital of £25,000, in 24,900 ordinary and 100 founders' shares of £1 each, to carry on the business of an electric light company in all its branches, and in particular to lay down, fix, and carry out all necessary cables, wires, lines, accumulators, lamps, and works; and to generate, accumulate, distribute, and supply electricity, and to follow the trades of electricians and mechanical engineers. The number of directors is not to be less than 3; qualification, £100; remuneration, £50 per annum and percentage. Registered office, 15, George-street, E.C.

Frederick Savage and Co. Limited.—This company was registered on the 16th inst., with a capital of £70,000, in £10 shares, to carry on the business of agricultural, general, and marine engineers, machinists, boiler makers, millwrights, implement manufacturers, brass and iron founders, shipwrights and general smiths; and the manufacturing and sale of all kinds of riding and roundabout machines for pleasure, such as used at fairs, and hitherto carried on by Frederick Savage; to purchase the land, workshops, and plant now forming the St. Nicholas Ironworks; and to acquire patents and privileges as may be deemed expedient. Registered without articles of association, with the registered office at St. Nicholas Ironworks, Gaywood, King's Lynn.

Official Gazette.

THE BANKRUPTCY ACTS, 1883 and 1890.

Receiving Order.

James Westlake, Perseverance Works, St. Dunstan's road, Bowcommon - lane, E., metal refiner and merchant.

Adjudication.

William Hartley, present address unknown, late carrying on business at the Tyneside Melting and Refining Company at Mushroom Quay, Newcastle-on-Tyne.

Order made on Application for Discharge.

Robert Hodgson Robinson, West Hartlepool, engineer — discharge granted conditionally.

Prize Competition.

We offer Four Guineas monthly in prizes for the best original Articles sent in on any Mechanical, Engineering or Electrical subject.

In order that Managers, Draughtsmen, Foremen, and Workmen who have had no practice in writing may not hesitate to send in competitions, it is to be understood that all articles will be fully edited and corrected, and judged of solely on their merits as original contributions from a practical point of view. The object of the competition is to induce practical men to come forward and give the results of their experience.

CONDITIONS.

Competitions for our Monthly Prizes must be sent so as to arrive at the Manchester Offices of The Mechanical World, New Bridge-street, not later than the last Tuesday in each month. Articles arriving after that time will be placed in the following month's competition.

Written competitions must be on one side of the paper only. The contributions must be original, and relate to matters connected with Engineering, Mechanism or Electricity.

The Proprietors of The Mechanical World reserve the right to publish any competition, whether it gains a prize or not.

The competitions may be accompanied by diagrams, sketches or drawings.

Competitors should write the words "Prize Competition" on the envelopes.

Competitors are not confined to one, but may send any number of competitions.

The correct name and address of the sender *must* be distinctly written upon every competition, not necessarily for publication. Competitions can appear under a *nom de plume.*

☞ We cannot undertake to be responsible for any MSS. sent to us, though when stamps are enclosed for the purpose we will endeavour to return rejected contributions.

Miscellaneous Items.

An elevated electric railway is projected in Naples.

Boats on the Erie Canal are to be propelled by electric motors fed by trolley wires.

One of the largest paper-making concerns in the States is now putting in electric bleaching plant for bleaching wood pulp.

The repairs to the "Howe," in the dry dock at Ferrol, are making rapid progress, and will probably be completed by the end of the month.

The managers of the Saxony railways have decided to light the whole of the Dresden stations by electricity, and also to supply them with motor power.

A special commission appointed by the French Minister of Marine to test the value of petroleum as fuel for torpedo boats, has given an adverse decision.

The London and North-Western and Caledonian Railway Companies announce that, commencing in July next, new corridor trains, with dining cars attached, both for first and third-class passengers, will be run by the West Coast route between England and Scotland.

A note has been received by the Department of Science and Art, through the Foreign Office, from the Austro-Hungarian Ambassador at the Court of St. James, announcing that a National Exhibition will be held at Buda Pesth, in 1896, commemorating the thousandth anniversary of the foundation of Hungary.

At the last ordinary meeting of the Institution of Civil Engineers for the session of 1892-3, held on the 16th inst., Mr. Harrison Hayter, president, in the chair, a paper was read on "Wreck-raising in the River Thames," by Mr. C. J. More, M.Inst.C.E., engineer to the Thames Conservators.

As the result of numerous trials, the Paris, Lyons, and Mediterranean Railway Company has decided to light fifty first-class four-compartment carriages by electricity, by means of accumulators carried in each vehicle. The accumulators are to be of the multitubular system, the electrodes being protected by a perforated celluloid covering.

The Massicks and Crookes hot-blast stoves at the Appleby Iron Company's works in Lincolnshire are said to be giving great satisfaction. Since their adoption the daily output of pig iron per furnace has almost doubled. The consumption of coke per ton of iron made is less, and the character of the iron has not deteriorated.

At the Cambridge Meeting (1894) of the Royal Agricultural Society, two prizes of £50 and £25 are offered for fixed oil engines of from four to eight brake horse-power, and two similar prizes for portable oil engines of from nine to sixteen brake horse-power. Particulars of the regulations of the trials may be had from the secretary, 12, Hanover-square, London.

Telegraphic communication in Persia is said to work fairly well in dry weather, but in times of rain and damp it is, unfortunately, far otherwise. This arises from the fact that the insulators are not fixed to poles of wood or iron, as with us, but are driven into trees that have branches growing round the hooks and touch the wire, thus intercepting the current. When a large tree is not available, a small one is resorted to, which often breaks, or the shaking of the slender tree by the wind dislodges the insulator or hook on which it is fixed, and the wire trails on the ground.

An electric boat railway in Japan is being constructed to connect the town of Kiöto (situated on a large river, at the mouth of which is one of the ports open to European commerce), with Lake Bivva, a sheet of water as large as Lake Geneva, and situated 11 miles from the town and 44 metres above the sea. The railway is provided with large trucks, on which the boats are placed. Each truck, has a dynamo motor which is in constant communication with a central station by means of a metallic cable. The horse-power at the central station is about 500, and is furnished by turbines. About 50H.P. is used in moving the trucks, which are three metres wide, five metres long, and three metres deep, but which can take boats seven metres wide and 12 metres long.

Queries.

☞ **Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.**

☞ **Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.**

Wood's Automatic Pressure Relief Valve.—Required the address of the makers of this valve.—Bell and Co.

Oil Merchants.—Will any reader give me the London address of the Cleveland Lubricating Oil Company, U.S.A.?—A.H.

Railway Crossings.—Given the ratio of intersection, what rule is generally used to convert into degrees of the quadrant?—L. V.

Cleaning Boiler Tubes.—Will some reader describe a useful tool to remove hard, thick scale from cross tubes in a vertical boiler? Tubes 9in. diameter and 4ft. 6in. long.—Novice.

Jigs for Drilling.—The Americans often use what is termed a jig for drilling. Will anyone kindly give a sketch, together with drill?—Driller.

Churchill Slide Valve.—Can any correspondent inform me who are the makers of the "Churchill Patent Slide Vale"? Any information would be thankfully received.—J. M.

Retempering Edge Tools.—Will any reader inform me if there is any method of tempering pattern maker's chisels and gouges that have been burnt in a pattern-shop?—Cymro.

Warsop Aero Steam Engine.—Any information about the working of the above engine, tried about 1870, such as the effect on the boiler, cylinder, piston rod, etc., will oblige—M. R.

Galvanising.—Can any reader inform me whether it is possible to do galvanising on a small scale, say 3 or 4cwt. spelter bath? also the process of preparing cast-iron work for the bath?—T. J.

Case-hardening Furnace.—Will any practical reader give a sketch of a good furnace for case-hardening purposes, cutter-heating, etc., gas, liquid fuel, or coke, or the name of any maker of such?—Lister and Co., Keighley.

Keys, Cotters, etc.—Can anyone inform me what kind of steel is used for making keys and cotter pins as used on most engines? The keys that are bought seem to be of better quality than the so-called mild steel as sold at very little more than the price of fair merchant iron.—Steel.

Steam Reversing Gear.—I should be much obliged if any reader will explain the working of a steam reversing gear for locomotives, which I have seen on the following railway companies' engines:—Glasgow and South-Western, Mersey Tunnel, and South-Eastern. A sketch would assist me.—F. Turton.

Theoretical Diagrams.—Will any reader sketch and describe the theoretical indicator diagrams which would be obtained from a set of triple-expansion engines, having given—Load on safety valves, 150lb.; height of barometer, 30in.; ratio of cylinder volumes, 1, $2\frac{1}{2}$, 5; total ratio of expansion, 8.—Hyper.

Metallurgical Furnace.—Can any reader furnish me with a scheme for supplying the heating power necessary for a metallurgical laboratory situated in iron-ore mining district, and where no gas is available? A small muffle furnace would be required, in addition to the ordinary heating power, and the fuel used is charcoal. Accommodation only required for one chemist.—H. S.

Condensing Coil.—In constructing a condensing worm and tank, what amount of coils are necessary so that the distilled water may be quite cold, and what would be the quantity of water in tank to obtain the result? How can I arrive at the final temperature of water originally cold which has passed through 500ft. run of $1\frac{1}{4}$in. pipe, the pipes being immersed in a tank containing water at a temperature of 200° Fah.?—Calor.

Wire Rope Transmission.—I want to transmit 60H.P. from a turbine running at 400 revolutions per minute, by a travelling wire rope to a mill main-shaft running at 250 revolutions, distance 100yds., and at 70yds. from turbine, a right-angle bend. There is a slight rising gradient from motor to mill. Will someone kindly tell me size of pulleys to use, diameter or circumference of rope, and speed? Can I drive direct without an intermediate gearing or countershafts? What is the best method of turning the angle, and should one or more ropes be used?—Miner.

Dynamo Winding.—Can any reader oblige me with the proper winding for an E.P.S. type dynamo of the following dimensions (in centimetres), so as to obtain at least 4 volts 3 ampères at a speed of about 2000 revolutions per minute:—Length of magnet bar, 11; length of yoke piece, 8·4; width of magnet and yoke piece, 5·3 each; depth of yoke piece, 2·5; thickness of magnet bar inside bobbin, 3; diameter of armature, 5; length, 5·3; air gap, $\frac{1}{2}$ millimetre all round? It has a laminated armature, with 12 interruptions $\frac{3}{16}$in. wide by $\frac{1}{4}$in. deep, and a corresponding number of sections in the commutator. The magnets are of Swedish cast iron. I have tried it with 2000 turns of No. 38 B.W.G. on the field and 120 turns of No. 26 B.W.G. on armature, but can get hardly any current.—E. P. S. Type.

Feed Pumps.—In working out feed pumps for common high-pressure engines, Molesworth says, p. 493:—"Take cubic contents of cylinder and one steam passage and multiply by 4, and divide by proper specific volume for given pressure." Why multiply by 4? There are only two cylindersful of steam discharged to one revolution or one stroke of the pump. Then, again, should not the cubic contents of cylinder be taken to cut off only? For instance if steam is cut off, say, at half-stroke, and initial pressure be 100lb., the specific volume for which is 270, we find a great difference from the plan of taking the full cylinder at the average pressure, which at 100lb. initial pressure will be 75 average, the specific volume for 75 being 353, not to mention the difference in the two cubic capacities. Feed pumps worked out according to Molesworth's rule and others always come out much too large—nearly three times. I shall be glad if some reader will explain this.—Cold Water.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ **Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.**

C. M'Arthur.—We would advise you to communicate with Prof. Roberts-Austin, Royal Mint, London.

R. M.—We believe no more parts have been issued. There is, however, a pamphlet on the "Strength of Iron and Steel" which may suit you, price 6d.

C. H. R.—We have your model and letter. You are mistaken in supposing that the matter has been overlooked. We have received a number of solutions, several of which we shall publish in a week or two.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.
Where complete specification accompanies application, an asterisk is suffixed.

8th May, 1893.

9133 Variable Expansion and Governor Valves. J Johnston.
9136 Clutching Device for use in Electric Arc Lamps. E J Paterson and J Foxcroft.
9141 Manufacture of Gas from Mineral or other Oils. J Laing.
9149 Telephony. C Adams-Randall.
9150 Traction Engines and Road Rollers. F J Burrell.
9154 Screw-down Cocks or Valves for Steam, Water, etc. W H Foster.
9162 Compressed Air Engines. A Rigby.
9168 Apparatus for Throwing Machinery in and out of Gear. W Beecroft.
9181 Gas and Oil Motor Engines. C D Abel. (*Die Gas Motoren Fabrik Deutz, Germany.*)
9184 Arc Electric Lamps. E C de Segundo.
9204 Electrical Measuring and Recording Instruments. H T Harrison.
9205 Turning Lathes. F Schotz.
9208 Appliances for Levelling. E M Sheldon.
9209 Square Drill. R Bennett.

9th May, 1893.

9212 Wrenches.* E B Smith.
9214 Portable Water Motor.* J Bolziano, jun.
9216 Internal Combustion Engines. J C R Okes.
9218 Rotary Pumps. J T Towlson.
9220 Locking Nuts on Screw Bolts. R Turnbull.
9222 Self-greasing Tram Wheel and Axle. D Thomas.
9223 Automatic Centre Coupling Buffers for Tight-lock Coupling of Railway Vehicles. J A Craven and T Foster.
9232 Ships' Telegraphs. E Fletcher.
9239 Instruments for Measuring, Gauging, and Comparing Distances. R W Slade.
9240 Tubular Boilers.* A Rodberg.
9246 Rotary Pumps. J T Towlson.
9247 Packing for Piston Rods. T Keene.
9250 Aerial Locomotive or Flying Machine. F C Morgan.
9252 Railway Signalling Apparatus.* J H T Morris.
9262 Electric Meters.* O Ericsson.
9272 Propelling Apparatus for Ships.* T Armstrong.
9273 Brake Blocks. E Edwards. (*H Koehler, Germany.*)
9274 Mantles for Incandescent Lighting by Gas. W F Stanley.
9277 Weighing and Testing Machines. G H Denison.
9281 Apparatus for Counting Telephonic Conversations. R H Gould.
9287 Apparatus and Methods for Filtering Water. G Weddell and J Clark.
9290 Journal Boxes.* H Deck.
9301 Screw Propellers.* (*A W Case, United States.*)
9302 Contacts for Underground Electric Railways.* W Q Prewitt.
9303 Apparatus for Replacing Railway Rolling Stock upon the Rails.* W P Thompson. (*H G Hanson, United States.*)
9304 Electric Lamps.* A J Boult. (*J Waring, United States.*)
9306 Cocks or Valves. W P Thompson. (*The Maschinen und Armaturen-Fabrik vormals C L Strube, Aktiengesellschaft, Germany.*)
9308 Machines for Equalising Electrical Currents without a Current Inverter. F Vogel.
9310 Automatic Cut-off Gear for Engines.* A J Boult. (*The Bruno Nordberg Company, United States.*)
9313 Multitubular High-pressure Steam Boilers.* A Lagrafel and J d'Allest.
9322 Chucks for Drills and the Like. C Scharenberg.

10th May, 1893.

9326 Ships' Telegraph Dials. J W Ray.
9332 Machines for Forming Dovetails in Woodwork. R Kerr and Sons and A M'Fadyen.
9341 Apparatus for Signalling on Railways. J Booth.
9343 Hydraulic Valves. G Heritage.
9358 Connections for Electric Lighting.* G Binswanger.
9361 Worm Gearings and Casings therefor. M H Smith.
9370 Steam Boilers. A J Maginnis.
9372 Belt Fasteners. T and W H Campbell.
9375 Axles and Wheels for Railway Rolling Stock.* W P Thompson. (*A Halmay, Austria.*)
9377 Vacuum Engines.* T J Sullivan.
9378 Means for Consuming Gases and Effecting the Combustion of Smoke in Furnaces.* W E Sander.
9380 Automatic Breaking of Current Circuit for Electric Lamps. R Haddan. (*A Reisinger, Germany.*)
9386 Car Coupling. W H and J T Starkey.
9389 Railway Brake Apparatus. J D Carmichael. (*P H Ripley and J Perrel, France.*)
9392 Ships' Steering Gear. W H Harfield.
9397 Taking or Transmitting Power from Electromotors. C R Garrard and T W Blumfield.
9400 Spring Motor. A C Flegal.
9403 Condensing Apparatus. J Schmittdiel.
9406 Improvements in Treating Malleable or Wrought Iron. J H Ladd.
9408 Driving Gear for Locomotive Engines.* D S Patterson.
9411 Safety Apparatus for the Cages of Mine Shafts. S Garratt.

11th May, 1893.

9413 Vice Screw. W Bracewell and others.
9415 Mandrels used in the Manufacture of Metallic Tubes. J Haley.
9421 Press-to Tube Wrench and Spanner. C Neil.
9428 Economisers or Feed-water Heaters for Steam Boilers. H Birkby and B Haigh.
9429 Steam Reducing Valves. W H Armstrong.
9431 Automatic Water Gauges for Steam Boilers. H B and J S Watson.
9432 Tubular Steam Generators and Tubes therefor. A Sime.
9440 Reflecting Instruments for Measuring Angles. J H Blakesley and J H Steward.
9444 Nut Locks.* J G Dulany.
9447 Screw-propelled Boats. F W Zimer.
9478 Insulators for Electric Wires. H H Lake. (*Hartmann and Braun, Germany.*)
9479 Turnstiles and Electric Counters connected therewith.* R Chavarria-Contardo.

12th May, 1893.

9482 Ventilators. H T Johnson.
9484 Water Gauges for Steam Boilers. C Billington, sen., and J Newton.
9486 Stands for Electro-motors for Dental Purposes. W Greenhalgh and S W Cuttriss.
9496 Ships' Course-recording Apparatus and Compasses. J Hope.
9497 T-squares. G Burridge and J Farningham.
9502 Stockless Anchors. A Wait.
9506 Petroleum-fired Furnaces. S Marsden and G C Marlow.
9510 Crushing Machinery. T Thompson.
9517 Steam Engines. J R Churchill.
9522 Apparatus for Automatically Preventing the Racing of Engines, and Screw Propellers of Steamers. A V Colston.
9525 Gas Engines. A Earnshaw and T Oldfield.
9529 Distribution of Electricity for Electric Lighting. J A McMullen.
9537 Railway Signalling Apparatus.* W Saunders.
9545 Fog-signal Apparatus for Railways. J G Dixon.
9548 Apparatus for Heating or Evaporating Liquids by means of Steam. D B Morison.
9549 Rotary Motors applicable also as Pumps. F B and A Dellattre.
9552 Microphones and Telephones.* T Paetzold.
9557 Dynamo Electric Machines and Electric Motors. H N Prentice.
9561 Ball Bearings. W Shears.

13th May, 1893.

9564 Steam Traps. E Hunt. (*R T Love, West Indies.*)
9574 Expansion Joints for Oil Pipes.* H B and J S Watson.
9577 Safety and other Valves for Steam and other Fluids. J Dugdale and J F Davies.
9579 Lifts. J M Shepherd.
9583 Oil Engines. H P Holt.
9593 Fire Bridges of Steam Boiler Furnaces.* R Brown.
9597 Steam Generators. R H Alexander.
9598 Railways. W J Bennett.
9599 Pipe Wrench. J A Smith.
9603 Heating Jackets and Receivers of Steam and other Motive-power Engines. R Hoyle.
9604 Pitch Chains. G Briest and others.
9612 Apparatus for Cutting Teeth in Wheel Blanks. W P Thompson. (*C M Conradson, United States.*)
9613 Cement Applicable for Leather Belting. W H E Boulton.
9618 Internal Combustion Engines. J Roots.
9619 Obtaining Copper. E Casper.
9621 Apparatus for Indicating the Stations on Railways. W C Betts.
9630 Electric Arc Lamps. L de Kostecki and A A Pical.
9632 Clutch. D W Fessey and F W Croome.
9633 Gas Regulator. A C Tobler.
9638 Central Office Apparatus and Circuits for Telephone Exchanges. E J Hall.
9639 Trunk-line Signalling Apparatus and Circuit for Telephone Exchanges. E J Hall.
9640 Electrical Signalling Apparatus and Circuits. E J Hall and F A Pickernell.
9641 Busy Signal for Telephone Circuits. E J Hall and F A Pickernell.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to Sir H. Reader Lack, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

All who are practically engaged in Mechanical Engineering or Scientific Industries are invited to avail themselves of THE MECHANICAL WORLD columns for information. We are glad to help the diffident, and, so far as we can, remove the obstacles which frequently prevent practical men from communicating their ideas.

We wish it to be distinctly understood that we cannot, for any consideration, and will not knowingly, allow our editorial columns to become the vehicle for mere advertisements of machinery, apparatus, or anything that falls within our province to notice.

Every correspondent should forward his name and address, not necessarily for publication unless so desired. We do not undertake to return MSS. unless specially requested, and in such cases stamps should always be sent.

All communications relating to editorial matters should be addressed to the Editor of THE MECHANICAL WORLD, at the Manchester, and not the London, Offices.

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☞ Owing to the large demand for back numbers of THE MECHANICAL WORLD, we are compelled to fix the following scale of prices:—Copies published in 1887, 6d. each; 1888, 5d.; 1889, 4d.; 1890, 3d.; 1891 and first half of 1892, 2d. each.

All remittances payable to EMMOTT AND COMPANY LIMITED, Publishers, either at New Bridge Street, Manchester, or 85, Strand, London, W.C.

FRIDAY, JUNE 2ND, 1893.

Progress in Flying Machinery.

AMONG the many attempts to accomplish aërial flight, the principle most favoured by modern inventors is that embodying the use of aëro-planes. Prof. Langley's experiments have thrown quite a new light upon this aspect of a subject which has never failed to fascinate inventors, and now Mr. Horatio Phillips, after twenty-eight years of study and experiment, claims to have successfully accomplished aërial flight by a machine constructed on a somewhat similar principle to the aëro-plane. Mr. Phillips has used inclined planes, and used them of large size, too, but he has reduced their dimensions step by step until the transverse sectional area of one of his present sustainers measures only 1½in. in breadth by ⅛in. in thickness at the front, tapering to nothing at the back. Broadly stated, the cross-section of the slat is that of a knife-blade, with a thin edge at back and a thick one at front, and with the upper and under side of the slat curved, but both differently. The form, in fact, is such that when the machine is in motion the convex upper surface near the front or thick edge deflects the air upwards, thus creating a partial vacuum on the upper surface of the slat. The under or concave surface of the slat is formed to a parabolic curve, which gradually puts the particles of air into motion downwards, thus producing an excess of pressure on the under side of the slat. It thus follows that upon a forward motion being given to the machine, the horizontal air-pressure which is brought upon the slats becomes converted, by reason of the form of the slats, into an upward vertical pressure which acts as a lifting power and raises the machine into the air. There are 50 of these slats, each 1½in. wide and 22ft. long. They are fitted 2ins. apart and with their edges horizontal, in a frame 22ft. wide and 9ft. 6ins. high. They have a combined area of lifting surface of 136 sq. ft., and they are carried in their frame upon a carriage resembling a canoe 25ft. long and 1ft. 6ins. wide at the rear, but tapering to a point at the front. The frame of slats is fixed transversely to the length of the carriage, and in outline the whole resembles a small boat fitted with a large sail. Upon the carriage and near the sustainers, which are at the rear end, are placed the engine and boiler and the air-propeller. The engine is compound, having cylinders 1¾in. and 3⅝ins. in diameter respectively, with a 6in. stroke and fitted with ordinary slide valves. The boiler is a cylindrical vessel of phosphor bronze 12ins. in diameter and 16ins. long. It has 12 sq. ft. of heating surface, made up of Field tubes of ⅜in. outside diameter and 14ins. long. The firegrate area is 70 sq. ins. and the fuel used is Welsh coal, the working pressure being 180lb. per sq. in. The propeller is two-bladed, 6ft. in diameter and of 8ft. pitch, and has 4 sq. ft. of blade surface. It is driven at the rate of about 400 revolutions per minute. The weights of the various parts of the machine are: Carriage and wheels, 60lb.; machinery with water in boiler and fire on grate, 200lb.; sustainers, 70lb.; total weight of machine in working order, 330lb. Experiments have been made which appear to show that the machine has a definite tendency to ascend, but as it is at present held captive it is impossible to say how it will behave in free flight.

Sparkless Dynamos.

IT is a long time since any radical departure was made in the design and construction of direct-current dynamos, and the fact that such an advance has now been made with beneficial results will no doubt be generally appreciated. In a paper read recently before the Institution of Electrical Engineers, dealing with the prevention and control of sparking, continuous-current dynamos without winding on the field magnets, and constant-pressure dynamos without series winding, Mr. Sayers described at some length a type of dynamo which constitutes a distinct progressive step. The object of the paper was to show certain means for bringing under independent control the commutation of ring and drum armatures for continuous currents; and the limits dependent on considerations of sparking at the brushes being thereby done away with, a new field of design was opened up. The author pointed out that several devices had been proposed for controlling sparking at the brushes, one being the introduction of a counter-electromotive force into the short-circuited coil, with the object of avoiding sparking and the necessity for moving the brushes with varying loads. Mr. Sayers had adopted special means by which he secured the sparkless reversal of the section under the brush at any desired place between the horns of the pole pieces, and the characteristic features of the new machine are as follows:—The air space is a mere clearance, being one millimetre. The reversal of the sections is effected by inductors or coils, which are termed "commutator coils," independent of the main winding. These commutator coils are so arranged as to be acted on by the pole-tip, which is strengthened by the armature current, and the brushes of the machine when run as a generator are set with a backward lead instead of a forward one. As the commutator coils enable the reversal of the armature sections to be effected just after they have emerged from under the strengthened pole, the result is that what have hitherto been called back turns of the armature winding become forward turns, and the effect of the cross induction is to increase the reversing field instead of diminishing it, and the manner in which they operate in producing it. The machine, which was illustrated in diagram, possessed all those features. It was self-exciting by means of the armature winding only—that is, it generated a current, behaving like a series machine, without any winding at all upon the magnets, which might therefore more properly be called "keepers"; and it ran absolutely without sparking at the brushes. In the discussion on this type of machine, two or three dynamo makers referred somewhat adversely to it, but most of the speakers commended the introduction of the commutator coils to accomplish the purposes mentioned. At any rate, as Mr. Sayers stated, and as others confirmed, the border had only been touched of a new field of design for continuous-current machines.

The Marking of Iron and Steel.

STEPS are being taken by the British Iron Trade Association with the object of having manufactured iron and steel regularly stamped as of British manufacture, and many of the leading makers are favourably disposed to the proposal. It is acknowledged that British goods are of superior quality, and it is urged in a communication now sent to the principal parties interested that the obvious commercial value of this recognition of superiority is not likely to accrue to the British manufacturers unless they have their goods so marked that the fact will be readily appreciated. It is probable, moreover, that foreign merchants and manufacturers will get credit that does not belong to them, unless the real manufacturers in Britain take such steps as will secure them the full advantage of their experience, care, and capacity. It is therefore suggested that, in addition to the usual markings of brand, etc., the words "British manufacture" should be similarly branded. It is not, however, proposed to attempt any compulsion. The special committee of the association on the subject deem it sufficient for the present to call attention to the obvious advantage of the suggestion. We are afraid, however, that very little advantage will accrue if the suggestion is only acted upon in a half-hearted manner, as appears likely to be the case. Moreover, so far as foreign markets are concerned, we fail to see what is to prevent our competitors abroad from stamping their products with the words "British manufacture," just as they branded the words "Sheffield make" on their cutlery some years ago.

A New Submarine Boat.

SOME time ago we referred to the tests off the coast of Italy of a submarine boat calculated to give a remarkable performance, but which entirely failed. Other nations, and notably France, Spain, and the United States, have similarly experimented. The United States Government has, however, now appropriated the trifle of £40,000 for the purpose of testing the Holland submarine boat, which will be 135ft. long, 16ft. wide, and 10½ft. depth of hull. The boat is to be protected by 24ins. of steel armour in front and 4½ins. on the sides and back of a turret, situated on the upper part of the vessel. One-inch plating and cocoa cellulose protect the sides above and below the light water line. Excepting only a part of the turret, from 4ft. to 6ft. of water will cover the entire boat when ready for action. This turret encloses a pilot house, air shaft for ventilation, a smoke stack, and a companion-way. If the forward part of the vessel were struck by a torpedo, it is said that the boat would not be disabled, as only the chamber for water ballast would be broken into. The armament is to consist of two submarine guns—one in the bow and the other in the stern—capable of throwing 200lb. and 100lb. charges of high explosives to a distance of 300ft. Projecting from the turret will be three 100lb. aërial torpedo guns, with a range of 1700yds. The forward submarine gun is 10ft. below the water surface, and is 30ft. long by 12ins. diameter. The engines are of 1500H.P., capable of giving a speed of 18 knots light, or 15 knots submerged.

Mr. H. H. Laird.

WE regret to record the death, on the 26th ult., of Mr. Henry Hyndman Laird, one of the partners of the eminent firm of Laird Brothers, shipbuilders, of Birkenhead. Mr. H. H. Laird, who was the fourth son of the late Mr. John Laird, was born on the 21st of May, 1838. He commenced his career as a shipbuilder at La Ciotat, near Toulon, in the works of the Messageries Imperiales de France, now the Messageries Maritimes Company, where he remained for about two years. He returned to this country in 1857, when he entered the Birkenhead Ironworks, belonging to his father. He passed through the various stages of his profession, and was admitted a partner in the firm, which at that time was known as Messrs. John Laird, Sons and Co. On the retirement of the late Mr. John Laird the title of the firm was altered to Laird Brothers, this change taking effect from July 1, 1862. Mr. Laird always held a front rank in connection with the design of vessels of war and of high speed, whether for ocean, channel, or river service, and was a thorough master of shipbuilding in every branch. He had been a member of the Institute of Naval Architects since 1874, and was elected on the council of that body in 1876, continuing to act in that capacity until his death. He was also a member of the Institute of Mechanical Engineers, to which he was elected in 1872.

Water Power.

AS pointed out some time ago, the abundant water supply in Switzerland has in some cases been taken advantage of by Swiss engineers and capitalists in the way of utilising it for industrial purposes, and extensions in this direction are constantly being made. One of the most recent schemes is to employ some of the power of the Rhine near Rheinfelden, and which is owned jointly by the cantons of Aarau and Baden. Negotiations which have been conducted for some time past with a view to accomplish this object have now been brought to a satisfactory conclusion. The available power is calculated at 15,000H.P. It is intended to utilise this 15,000H.P., part of which will be taken up by the Neuhausen Aluminium Company, who already profitably employ water power in the production of aluminium, and whose installation was described in our issue of August 15, 1891. The remainder of the power will be electrically transmitted for use in developing the industries in the district.

Grooving in Steam Boilers.*

OF the various forms in which corrosion is met with, grooving or channelling is certainly one of the most important. It usually occurs at the joints of the plates to each other, or to some fittings, or other parts of the boiler. Internally the effect is more generally due to the localisation of corrosion owing to the fact that the plate at that part is subject to some bending action tending to disintegrate the surface, and thus facilitating any corrosive action of the feed water. Externally the grooving is generally due to leakage at or adjacent to the defective part, and unless there be brickwork or other materials in contact with the plates, the wasting is usually local.

The mechanical action which results in grooving at the longitudinal or ring seams, when the water is corrosive, is usually due to the fact that, owing to the lapping of the plates at the seams, the stress is not transmitted directly, and a certain bending action is therefore set up close to the lap of the seam. This action may generally be noted when lap-riveted pieces of plate are tested by tension to destruction. The upper of

* Extract from the Chief Engineer's Report of the National Boiler and General Insurance Company Limited, Manchester.

the annexed sketches (Fig. 1) shows two pieces of plate before stress has been put on them. When under severe strain the action referred to above results in the edge of the joint opening, and bending taking place at the points marked D and E in the lower sketch. The same action, though to a less degree, occurs in an ordinary boiler shell, both at the longitudinal and ring seams, when these are lapped, the variations of steam pressure from time to time causing an alternate bending to and fro, rendering the plate adjacent to the lap more vulnerable, and with corrosive water, frequently resulting in more or less severe grooving. The annexed figure (Fig. 2) illustrates a case which

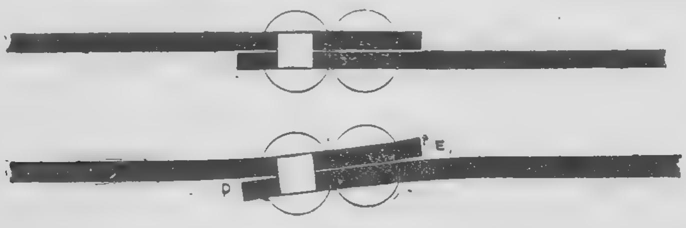


FIG. 1.

was met with in the past year, and detected by one of the inspectors, thus avoiding disaster. This grooving was deep, and nearly penetrated the plate, as shown on the cross section, and extended almost continuously across the plate. Occasionally cases are met with where the grooving is of a much more acute form than that illustrated above, the grooving being very narrow and deep, more like a fine fracture or nick. One of these grooves was recently detected in a locomotive. Grooving of this particular character has been responsible for a number of explosions of locomotives, and has been found to occur

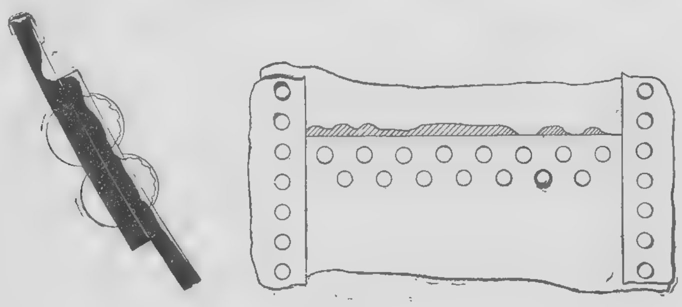


FIG. 2.

where other parts of the boiler did not show the water to be of a violently corrosive nature. It is probably to be attributed, in the first instance, mainly to punishment and straining of the plates in construction. It would appear that some makers of locomotive boilers do not construct the boiler shells with the same care which is taken with the manufacture of high-class Lancashire boilers. Locomotive boilers, although intended for high pressures, in many cases are often made with the rivet holes in the shell plate punched before the plates are bent. When this is done, it is difficult to avoid undue bending and distress being caused near the line of rivet holes when rolling the plate to form, and, in some instances, the final bending of the plate near the edges has been done by means of a sledge hammer. Where a plate has been treated in this way, there is no reason for

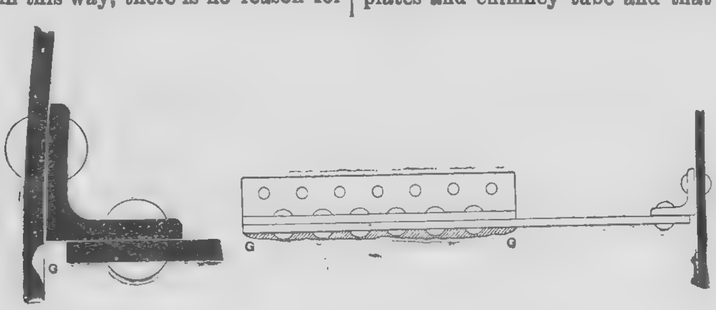


FIG. 3.

surprise if grooving as described above afterwards occurs, and, in view of the high pressure which is used in locomotive boilers, and the mechanical straining to which the boilers would appear to be subjected in the course of their working, owing to shaking in passing round curves, etc., it is of the highest importance that their construction should be on the best possible lines. Shells should be constructed of mild steel plates, each ring being made from one plate, with the longitudinal seams fixed above the water level, these being butt joints with double strips. All the rivet holes should be drilled after the plates have been bent to form.

When lap seams are under compression, as in the longitudinal seams of furnace tubes of Lancashire and Cornish boilers, a similar action to that described above takes place, though in a reverse manner, and grooving is frequently met with at these parts. Two cases of very peculiar grooving were noted at the edge of the angle irons connecting gusset stays to shell plates. One of these is indicated on Fig. 3, a deep channel G being formed, extending the full length of the angle attaching the gusset plate to the shell. This was probably caused by mechanical action due to the gusset plate drawing the shell a little from the true circular form.

Grooving of the end plates above the furnaces is probably the commonest and least dangerous form of this defect. It occurs in Lancashire and Cornish boilers, being generally more severe at the front than the back end, and is due to the bending of the end plates owing to the expansion of the flue and furnace tubes. The local high temperature at the furnace end of the tube causes the "hogging" of the tube due to the above cause to be more severe at the front than the back end, and the grooving of the front end resulting is generally deeper than at the back end. Where ends are properly stayed such grooving is seldom dangerous, although it may necessitate expensive repairs.

Fig. 4 illustrates a case of this grooving in which the tube was attached to the end plate by an angle ring, and the same movement which caused the grooving G of the end also resulted in a groove A being formed in the bend of the angle iron. In tubes which are constructed with ring seams, lapped and riveted in the ordinary way, the small movements due to same cause—unequal expansion—frequently cause grooving at the furnace and flue tube ring seams.

A common and serious form of grooving is that which is met with on the furnace crown plates of ordinary vertical boilers, and is generally due to the straining of the plate near the connection to the chimney tube arising from the difference between the vertical expansion of the furnace plates and chimney tube and that of the shell. This expansion is at times unusually great, as these chimney tubes in the steam space very often become much overheated. Fig. 5 shows grooving G of this kind round the base of the chimney tube. Grooving of this character was met with in a large number of cases in the past year, and in some fracture of the plates had actually commenced when the defect was noted. It was responsible for the explosion of a vertical boiler. The overheating and consequent excessive expansion of the chimney tube which is largely responsible for this form of grooving, may be greatly reduced by protecting it on the fire side by a cast-iron liner or similar appliance, as has frequently been advised in these reports.

It is to be regretted that only few vertical boilers are protected in this way, and generally it is to be remarked that though these boilers give rise to a large number of serious explosions, their design and construction does not usually receive that care which is so desirable.

FIG. 4.

Various other forms of grooving are met with; and, in fact, it may generally be stated that wherever parts of boilers are in the course of ordinary work subject to material movement, either owing to alteration of form due to pressure or to changes of temperature, grooving will take place if the water be at all corrosive.

In portable boilers the expansion of the firebox causes movement of the stays, and

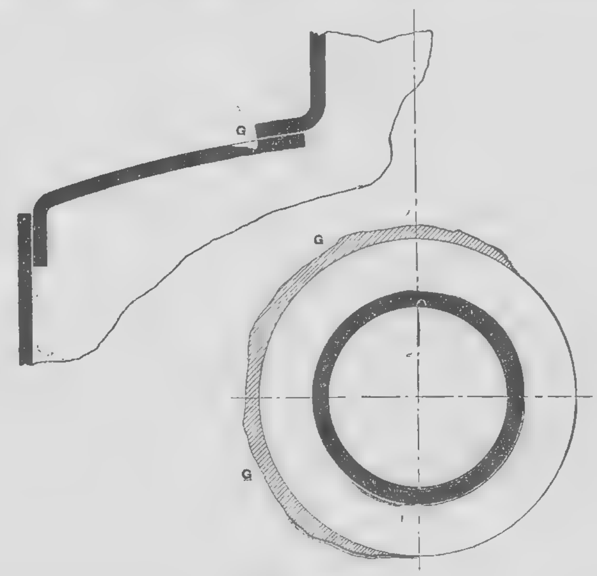


FIG. 5.

frequently these are severely reduced at their junction to the firebox casing plates. In boilers of this class, also, the corners of the flanges connecting the firebox to the casing at the bottom are also much grooved, arising from the same cause.

One of the commonest forms in which this occurs is that of grooving round the joint of some fitting block attached to the shell plate. This generally arises from leakage at the joint, and is more commonly met with in old boilers to which the blocks are, in very many instances, con-

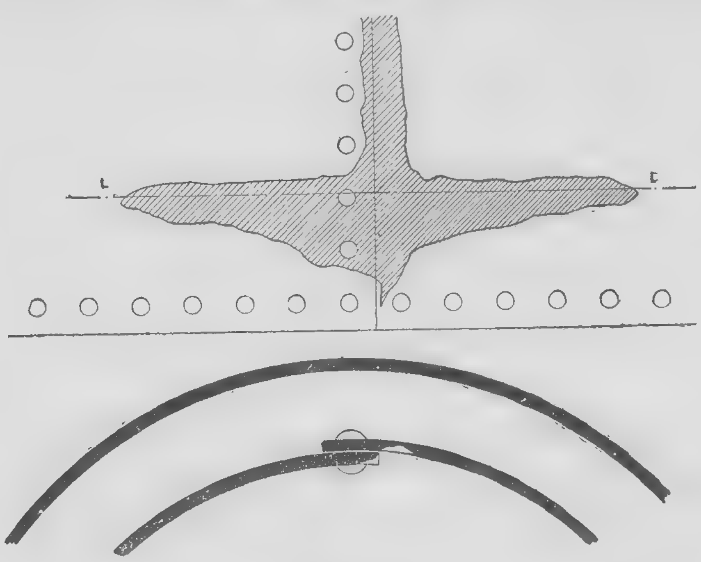


FIG. 6.

nected by bolts. Another common form of the grooving occurs at the vertical seams of ordinary vertical boilers or of portable boilers. An instance of this is illustrated on Fig. 6. The wasting is commonly confined to the part at which the leakage occurs, but if this should be near the bar level L, where the proximity of the bars may result in damp ashes being kept in contact with the plate, sometimes more serious and extensive wasting results, as shown on the sketch.

In considering the case of an example of grooving, it must always be remembered that wasting at these parts is much more serious than corrosion to a similar depth at or near the centre of the plate. Internal grooving at longitudinal and ring seams, as before mentioned, may be ascribed usually to corrosion localised near the joint, caused by slight bending to and fro at this part. The same mechanical action which results in grooving in the first instance tends to accentuate and cause it to be more acute near the lap of the plate afterwards. In determining the weakening effect of grooving, therefore, the strength of the grooved plate to resist this bending action must be taken into account, and in this connection it must be remembered that, generally speaking, the resistance of a plate to bending varies with the square of the thickness. It must usually be considered, therefore, in such cases that the ultimate resistance of the plate is reduced by grooving in a much greater ratio than is indicated by the ratio of the wasted thickness to the original thickness.

A large number of instances have been met with during the year in which boilers have been very rapidly generally wasted on the water sides owing to the corrosive nature of the feed water.

In some of the large manufacturing towns in which processes are carried on involving the use of acids, it would appear that acid waste is occasionally turned into the streams. This most dangerous pollution has caused disastrous explosions in the past, and only recently we have met with cases where wasting of iron plates to

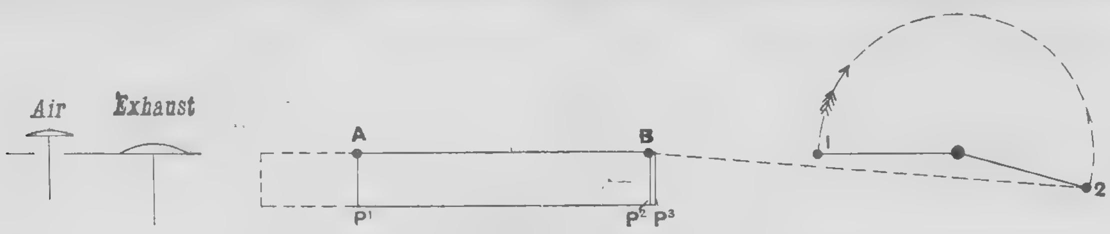
a depth of ⅛in. to 3/16in. has been caused by pollution of this nature in less than twelve months.

Frequently wells are sunk and the water used for feeding boilers without any careful test having been made as to its suitability or otherwise. The water may be rendered unsuitable for the use of steam boilers by the presence of suspended matter, or by its excessive hardness or corrosive properties, and it is dangerous to use water for feeding until its properties in these respects have been carefully determined. In several cases, where wells have been recently sunk in large works and the water used for feeding the boilers, serious corrosion has been found to result, which, on investigation, proved to originate from a pollution of the water arising from leaky tanks containing acids from the works.

Many boilers at collieries and other mines are fed with water which has percolated through strata containing various minerals. In some cases this water is of a violently corrosive nature, and really unfit for use in steam boilers. In one district in this country where the attention to such matters has been rather backward in times past, boilers are very generally fed in the way described, and a considerable proportion of them have been found to be very seriously wasted by corrosion, the shell plates about the water level being especially reduced, in some instances to a maximum depth of ¼in. It appears to have been the practice in the particular cases referred to to cover the defective parts by means of plates bolted over them, the intervening space between the two plates being filled with red-lead cement. The practice of concealing wasting in this way cannot be too strongly condemned. It has frequently led to an altogether erroneous idea being formed as to the boiler's strength, and disastrous explosion has followed. Wasting should never be concealed, but if not so serious as to require repair, it should be left open, so that the condition of the part may be regularly noted afterwards. The proper course where feed water is found to be corrosive is first to endeavour to procure a better supply of water. If this be impracticable, steps should be taken to have the water analysed, so that the necessary steps to neutralise the acid properties of the water may be ascertained.

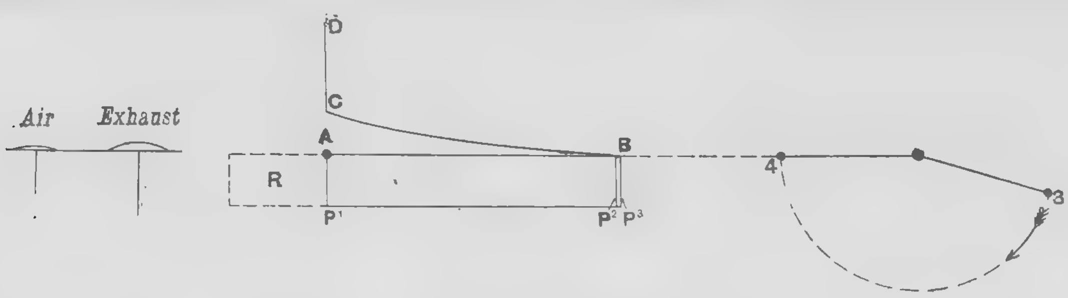
The Gas Engine.—I.

It is intended in this series of articles to give some practical information on the gas engine not readily obtainable outside the workshop, as there are no practical treatises on the gas engine, although there are some three or four text-books on the subject, more or less theoretical, and consequently of little use to the practical man. Engines with the "Otto" cycle will be dealt with, but earlier engines may at times be referred to.



Gas Engine.—Fig. 1.

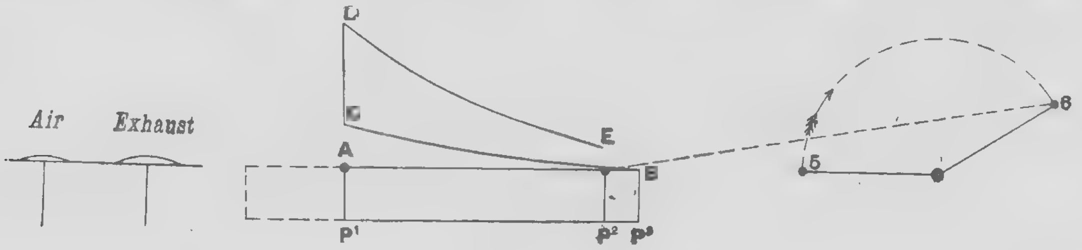
In engines with the "Otto" cycle, and which have one firing stroke every two revolutions, or four strokes, the mode of working is as follows:—On the first and out stroke, air and gas are drawn into the cylinder; on the second and return stroke, the charge of air and gas is compressed into a clearance space, generally at the back of the cylinder; on the third and out stroke, the charge is fired at the commencement, and expansion of the hot gas impels the piston forward; and, finally, on the fourth and return stroke, the burnt gases are expelled from the cylinder. In Figs. 1, 2, 3, and 4, strokes 1, 2, 3, and 4 are respectively represented by skeleton figures, in which A B represents the stroke of the piston and also the atmospheric line of an imaginary diagram, about which we will say more further on. P¹, P², P³ represent the position at different points in the stroke, R representing the clearance space at the end of the cylinder. The path of the crank-pin for each event of the stroke is drawn in dotted lines. Fig. 1 represents the charging stroke, P¹ being the position of the piston at the commencement of the cycle. Here the air and gas valves commence to open. P² is the position of the piston at the end of the charging stroke; here the air valve closes; the gas valve a little before.



Gas Engine.—Fig. 2.

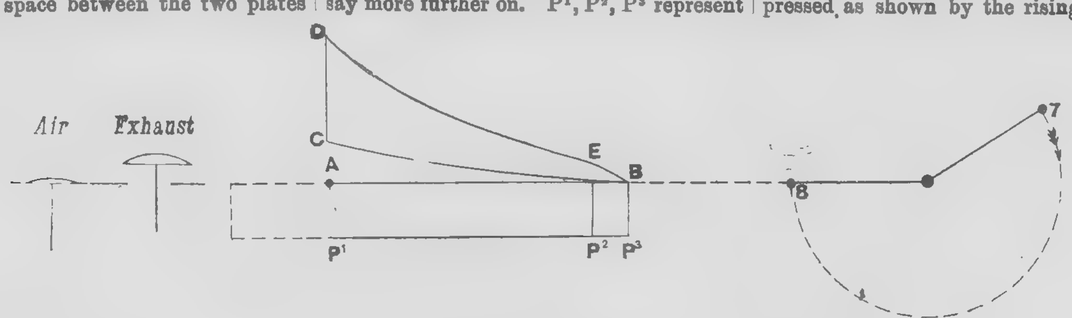
We have now a charge of air and gas in the cylinder, and the piston in position P², 2 being the corresponding crank position. In Fig. 2 the piston on its return stroke travels from P² to P¹, and in doing so compresses the charge into the clearance space R. The charge is then fired by an ignition tube or other firing arrangement. In Fig. 3 the force of the explosion and the expansion of the gases impel the piston forward. The exhaust valve commences to open when the piston reaches P², this lead in the opening of the exhaust valve being necessary to avoid undue back pressure. The position of the valves during the different strokes is shown to the left in the figures.

Having briefly described the cycle of operations, it will be well to represent them graphically, so that we may know what to expect in an indicator diagram. Quantitatively speaking, the indicator diagram affords a means of ascertaining what indicated horse-power an engine is developing. Qualitatively, it shows whether the power is in proportion to the gas consumed. And here it should be noted that if by the addition of a little more gas to the charge the power is increased, it does not follow that the efficiency of the motor is also increased.



Gas Engine.—Fig. 3.

Returning to the figures, A B represents the atmospheric line of a diagram, as well as the stroke of the piston, so that any point along A B, or parallel to it, will represent different positions in the stroke, and any line drawn vertically to A B from any point will represent the pressure at that point. The charging line in practice is a little below A B, as will be afterwards explained. In Fig. 2 the charge is compressed, as shown by the rising line B C, while the charge is fired at P¹, as shown in the sudden rise of the line C D. In Fig. 3 the diminishing pressure of the expanding gases is represented in the diagram by line D E, while in Fig. 4 the out stroke is completed, but as the exhaust valve opened at E, the pressure falls rapidly until it reaches the atmospheric line at B. On the return stroke the piston drives out the remaining gases, except those in the clearance space. The exhaust line is made to coincide with the atmospheric line in this imaginary diagram, but in practice it is a little above, to a degree depending upon the length and size of exhaust pipe, bends in the pipe, etc., and the speed at which the engine is running.



Gas Engine.—Fig. 4.

(To be continued.)

The Lubrication of Marine Engines.

(Concluded from page 204.)

Other bearings in which the gudgeons or pins have not a revolving motion cannot be treated in the same manner. As their frictional motion is equally distant from the vertical points, their supply may be considered as correct; but in a great many cases a more automatic system might be adopted. For instance, in beam links and pump levers, in most cases these bearings are not fitted with boxes or cups, but simply have a hole through the top brass; and although we know they require lubrication as much as any other bearings, still the supply is invariably left to the few drops given from the oil can. These sometimes reach their destination, but oftener do not.

Let us for a little while leave the engine-room and take a look at the tunnel shaft bearings, the principal of which is the thrust block. This is a bearing which stands, I may say, by itself, as the friction is on the fore and aft parts, instead of top and bottom. Here some interest seems to have been taken in the lubrication supply, as every ring is fitted with its own pipe and syphon; but still I think there is room for greater improvements. Many of you will have seen, and perhaps assisted in the making of extra receiving cups for the fore and aft ends of the block, connected by an inclining pipe running towards the after cup, so that the oil which is continually working forward fills the cup to the height of the pipe and returns again to the after end, thus keeping the thrust, as it were, running in a bath of oil. This arrangement must be acknowledged to be successful by all who have had anything to do with it, for after two or three hours' running the syphons can be entirely dispensed with and the bearing requires no further supply (if all the connections are tight) for many days. Now, although this is a very old arrangement and its success cannot be disputed, I have never seen, nor have I ever heard of it being fitted in the first place to a new engine, it being always left to the engineer of the ship to make and attach it himself, although he cannot always have either the time or material to do the necessary work in a proper manner. If it is of so much benefit, why cannot the designers see that it is done? They will go to a greater expense in fitting an elaborate water service, but the oil supply must remain in the old way. The other tunnel bearings do not require so much care and attention as the thrust; but even here I think better results would be obtained if they were all fitted with these fore and aft cups and automatically served.

A great many ideas have been recently brought before our notice for lubricating the propeller shaft with oil instead of allowing it to run in water, but I am afraid all are of too complicated a nature to be brought into general practice. If carried out in an easy and satisfactory manner, no one will deny, I am sure, that it would be the saving of many a shaft now being ruined through running in salt water.

In bringing this part of my paper to a close, I trust I have clearly expressed myself, perhaps not so plainly as you might wish, but you may agree with me that the defects I have pointed out are not uncommon; and in the marine engine of to-day, brought up as it is to great perfection in design, lubrication should not be overlooked or slighted. Regularity is one of its chief features; and let the "greaser" be ever so careful and competent, there must at times be periods in his watch, either through rough weather or extra attention required at some particular part, when this regularity cannot be carried out, consequently bad lubrication takes place. Every bearing throughout the engine should be supplied automatically and regularly; and if it can be carried out in small engines (as is now being greatly done), how much easier can it be arranged with the large machines of to-day?

Perhaps at this point a few words may not be out of place in regard to the rule in a good many steamers (not liners, but in what are called outsiders or tramps), of the engineers having to oil the machinery *unaided*. In these times, when we are trying to elevate ourselves and those who are to follow us, and to bring a more scientific training into every-day use, it seems very wrong that trained engineers should be

turned into oil feeders. No engineer in charge of a watch can properly devote his attention to all in his charge, be it ever so small, if his time has to be taken up with oiling; something must be neglected. Greasers should be taken from the firemen—good experienced men; for what does a young man fresh from the factory, or class, with "science dripping from his fingers," know of oiling machinery? That what I have referred to is done, we know, but it can only be to the owners' ultimate loss. There must be great waste and great loss. If our position requires elevating, this, I think, is one point which requires attention.

Having so far remarked on the various methods of external lubrication, and pointed out what I consider a few of the many defects in its supply, let us look now at internal lubrication, and see if any alteration for good can be made in that direction. Without doubt, in recent years a great improvement has been brought about here. The old pot impermeator has been entirely superseded by the automatic sight-feed—an arrangement in all its workings simple and effective. With the old style, oil was generally put in twice a day; if it worked, well and good; but generally it did not; now every drop tells a tale, and gives the satisfaction, with the knowledge, that all is going well. In the present day, with steam of very high temperatures, little, or perhaps no external lubrication is necessary. Many engineers have entirely discarded the supply through the impermeator. But with this I do not agree. Granted that the high-pressure steam requires no oil, when this steam reaches the low-pressure engine the temperature has decreased greatly, and here it is where I always find that most mischief takes place. With the large working area of the low-pressure piston, some lubrication, I consider, is necessary; very little suffices, but still some is required. If the impermeator, instead of supplying the oil to the steam at its first initial pressure, were so placed that the supply could be given at the time the steam entered the low-pressure valve chest, I really think more good would be done, as the lubricating properties of the oil would not be destroyed through coming in contact with steam of high temperature, but would pass at once into the parts requiring it most.

With internal lubrication, we must not overlook that taken in with the piston rods—an amount, I am afraid, greatly overlooked by most engineers in their calculations. Although all given to these rods cannot be absorbed by the steam, still I consider at least twenty per cent. is used for that purpose; and on no consideration should any but mineral oils be used. With engines having top end rods, automatic supply is very easy; and I find that the bottom rods can be as easily supplied as the top, and from my own personal experience good results have been obtained, not only in the life of the packing, but in the wear of the rods themselves. With a pair of engines of 2500H.P., I find that the piston rods (with top ends oiled automatically) and three valve spindles require one pint per watch of four hours' duration—*i.e.*, six pints in twenty-four hours. Now if, as I maintain, a fair percentage is absorbed by the steam while the rods are internally working, we have from one to two pints used from this source alone for internal lubrication, and the impermeator being fixed to the low-pressure valve chest would use 0·8 pint. We have therefore used two pints in the twenty-four hours. Not a very large amount, and I do not think it can be very much reduced. The supply required for the high-pressure cylinder is taken in by the piston and valve rods, and for the low-pressure by the impermeator.

In conclusion, I hope that however common the ideas thus brought to your notice, and however simple the remedies proposed may appear, some good may result from this paper in such an alteration as is required where a proper system of lubrication has been neglected, and where no thought seems to have been given to any improvement, except as to sight-feed impermeators; and since their introduction, how many different methods have been brought to our notice, each one, of course, better than its neighbour! but none, I think, has reached the root of the evil. Friction I would call the strongest enemy in a marine engine; and if lubrication is the best way to overcome it, the most perfect method should be adopted—therefore let us all try to find it.

The following points have been present to my mind while writing, and it may be well to mention them here:—

1. All revolving shafts should be supplied with lubrication, not through the vertical centre, but somewhere at the sides.

2. Every supply outlet to the crankpin should have its own separate supply inlet from the commencement to the finish.

3. Each and every bearing, whether small or great, should be supplied automatically; there should be no chance lubrication in connection with a marine engine.

4. No internal lubrication should be used, excepting through the impermeator affixed to the low-pressure engine, and also by swabbing piston rods and valve rods with mineral oils alone.

5. Greater thought and more care should be given by designers and builders to the lubricating arrangements, and less to the superfluous water service.

On the Variability of the Water Level in Locomotive Engine Boilers.*

ATTENTION is called to the changes in the water level in the boilers of locomotives, due more especially to starting and stopping. By means of diagrams, the author explains how the water surface takes an inclined line, being either heaped up over the firebox in starting or rising rapidly towards the funnel end in coming quickly to a standstill under the application of brake power. The angle of inclination can, if the weights of the engine, tender, and train are known, be calculated, and formulæ for this purpose are here indicated, showing the effect of stopping an express train with an assumed total weight of 220 tons, travelling at fifty-six miles per hour. By the application of these formulæ it is shown that, under the given conditions as to brake power and friction, the inclination of the surface of the water would be about one in fourteen, or, supposing the total length of the boiler and firebox to be 18ft., the fall in the water level from front to back would be about 15½ins. It is assumed in this calculation that the water surface would be bounded by parallel lines; but this is not the case, and as the enclosing lines are curved, the slope would not be a uniform one. Various factors, such as brake resistance, reversal of engine, etc., may tend to increase the angle of inclination, and, as the author points out, may dangerously expose the top of the firebox to superheating. The minimum height of water above the top of the firebox is, according to the regulations for the chief railways of Germany, fixed at 4ins.; but in coming to a rapid stop, which it is calculated could be effected in the assumed train in a distance of 1476ft., the top of the firebox might be absolutely bare for an interval of 35secs. No information is available as to the possibility of heating the firebox cover to redness in this time with no steam blast at work, though it is scarcely probable that this could take place. The author thinks that practical experiments respecting the questions raised are, however, desirable.

* Inst. C.E.; Foreign Abstracts.

The Design and Construction of Stationary Engines.—LIV.

The Fly-wheel.—The reciprocating motion of the piston is converted into circular motion through the intervention of the connecting rod and crank. The pressure on the piston is in most instances a varying one, and this imparts an inconstant effort on the crankpin which produces a varying angular velocity of the crankshaft. This variation it is usually very desirable to reduce to the smallest possible limits, and is effected by employing a fly-wheel of greater or less weight, according to circumstances. The inertia of the wheel tends to equalise the stress exerted during each revolution of the engine.

The fly-wheel may therefore be regarded as a regulator or controller of motion, modifying the irregularities of effort on the crankpin. The fly-wheel absorbs power from the engine at the commencement of the stroke, when the driving power is in excess of the resistances, and gives it out again towards the end of the stroke, when the resistances are in excess of the driving power.

The fly-wheel is in no sense a creator of power, but is simply a reservoir of energy. This energy, or accumulated work stored up in the wheel, it is necessary to consider. In calculating its amount, the influence of the mass of the arms and boss is usually neglected; but in the case of very large fly-wheels it may be desirable to take it into consideration, when the following formula may be used:—

Let N = number of revs. per second, $\pi = 3{\cdot}1416$, g = acceleration of gravity = 32·2, W_1 = weight of rim in lb., W_2 = weight of all the arms together in lb., W_3 = weight of boss in lb., R_1 = outer radius of rim in feet, R_2 = inner radius of rim in feet, R_3 = outer radius of boss, R_4 = inner radius of boss or radius of shaft in feet.

Then, assuming the boss and rim to be of plain rectangular section, and allowing for the effect of the slight taper of the arms by taking their centre of gyration to be at the middle point, the accumulated work in foot-lb.

$$= \frac{(2\pi N^2)}{g}\left\{ W \frac{R_1^2 + R_2^2}{2} + W_2 \frac{(R_2 + R_3)^2}{2} + W_3 \frac{R_3^2 + R_4^2}{2} \right\} = 0{\cdot}308\,N^2[W_1(R_1^2 + R_2^2) + W_2 \frac{(R_2 + R_3)^2}{2} + W_3(R_3^2 + R_4^2) \ldots (1)$$

If the rim only be taken into account, formula (1) reduces to

$$= 0{\cdot}308\,N^2 W_1 (R_1^2 + R_2^2) \ldots\ldots\ldots (2)$$

or it may be given by the usual formula, which takes into account only the linear velocity at the centre of gyration. Where E=energy or accumulated work in wheel, W=weight of wheel in lb., g=32·2, v=mean velocity in feet per second of centre of gyration of wheel,

$$E = \frac{Wv^2}{2g} \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The centre of gyration is the distance from the centre of wheel at which the whole of the weight may be supposed to be concentrated so that its effect is the same as the sum of all the weights of the various parts of the wheel, acting at their respective distances from the centre. It is usual in fly-wheel calculations to assume the centre of gyration as the inner radius of rim.

For a given number of revolutions N per second, the velocity v varies with the length of the radius r, and equals $2\pi r N$. Substituting this expression for v in above equation (3), E becomes

$$= \frac{W 4\pi^2 r^2 N^2}{2g} \ldots\ldots\ldots\ldots\ldots (4)$$

From which it will be seen that the energy varies as the square of the radius.

Example: Suppose a fly-wheel weighing 6000lb., with a mean radius of 5ft., and making 60 revolutions per minute, how much energy has it?

The mean velocity per second v

$$= \frac{2\pi 5 \times 60}{60} = 31{\cdot}4\text{ft.}$$

The energy E

$$= \frac{Wv^2}{2g} = \frac{6000 \times 985{\cdot}9}{64{\cdot}4} = 91{,}854\text{ft.-lb.}$$

A fly-wheel when revolving is acted on by forces, the effect of which is that every particle tends to fly out radially; this tendency is resisted by the tensile strength of the material. Owing to the uncertain character of cast iron, it is necessary to use a large factor of safety in calculating the strength of the rims and arms. The stress on the rim of a fly-wheel at either end of any diameter is found by the formula:

$$F = \frac{R \times N^2 \times 0{\cdot}00034 \times W}{2 \times 3{\cdot}1416} \ldots\ldots (5)$$

Where R=mean radius of fly-wheel in feet, N=number of revolutions per minute, W=weight of rim in lb., F=stress on rim in lb. The proof of this formula will be found in most works on dynamics. As an example, take a fly-wheel 16ft. in diameter, the mean radius taken at 7·37ft., the number of revolutions 75, and the weight 31,360lb.; then

$$F = \frac{7{\cdot}37 \times 75^2 \times 0{\cdot}00034 \times 31{,}360}{2 \times 3{\cdot}1416} = 67{,}414\text{lb.}$$

This divided by the sectional area of the rim (150 sq. in.) gives 450lb. per square inch as the stress on the rim. This is a moderate stress. When made in halves, the wheel rims are joined together by dowels, which should be sufficient to withstand the stress with safety.

Allowing 5000lb. per square inch as a safe stress for wrought iron, the section of the dowels for above example should be $\frac{67{,}414}{5000} = 13{\cdot}5$ sq. in. The dowels actually used were 4½in. × 3½in., with cotters 5in. × 1½in. The actual section of the dowels through cotter holes was therefore about 11·74 sq. in., or equivalent to a stress of about 6000lb. per square inch.

A convenient formula for finding the bursting speed for any material is the following:—

$$V = \sqrt{\frac{g \times T}{12 \times C}} \ldots\ldots\ldots\ldots (6)$$

V=velocity of rim in feet per second, g=32·2, T=tensile strength of material, C=weight of a cubic inch of material. For cast iron we have T=18,000, C=0·26; for wrought iron T=50,000, C=0·27; for cast steel T=75,000, C=0·28. We have therefore $V = \sqrt{\frac{32{\cdot}2 \times 18{,}000}{12 \times 0{\cdot}26}} = 431$ft. per second for the bursting velocity, for cast iron, without regard to the actual dimensions of the wheel. It is usual not to allow the speed to exceed 80 to 100ft. per second.

The great danger in running wheels at high speeds arises from the fact that if from any cause the speed is suddenly accelerated, by reason of the load being thrown off, causing the engine to run away, the centrifugal or radial force set up thereby increases with the square of the increase in the velocity; consequently doubling the speed quadruples the stress on the rim.

The bursting speed is dependent only on the velocity and the tensile strength of the material, and is independent of the *quantity* of material in the rim, since any increase of rim section increases the strength and the radial force in precisely the same proportion, and the bursting speed remains unchanged.

Fly-wheels for engines of small power driving by means of ropes or belts are generally made with straight arms of elliptical section, the major axes of which are parallel to the plane of rotation. Many small wheels are also made of I section.

The number of arms is fixed arbitrarily by the designer. They are usually in the smaller sizes cast solid with the rim and boss, parted at the boss to allow for contraction in casting, and are either hooped, bolted or dowelled together, and may therefore be considered as solid for purposes of calculation.

(*To be continued.*)

Shipbuilding Notes.

Messrs. Russell and Co., of Greenock, have, it is stated, received an order to build a steel sailing ship of 3600 tons cargo capacity for the King Line of Messrs. John A. Walker and Co., of Glasgow.

Messrs. Fleming and Ferguson, Paisley, launched on the 18th ult. a twin screw hopper barge for the Clyde Trustees. She will be fitted by the builders with two sets of triple-expansion engines indicating 1200H.P., which are expected to drive her at a speed of 10½ knots when loaded.

The British India Steam Navigation Company's new steamer "Bezwada," built by Messrs. Alex. Stephen and Sons, Linthouse, ran her official trial trip in the Firth on the 23rd ult. Her dimensions are:—Length 400ft. between perpendiculars; breadth extreme, 48ft.; depth moulded, 31½ft. The engines have cylinders 24, 41, and 67ins. diameter, by 48ins. stroke. The trial was highly satisfactory.

On the 18th ult. there was launched from the Cleveland Dockyard of Sir Raylton Dixon and Co., Middlesbrough, a steel screw steamer. The principal dimensions are:—Length, 327ft.; beam, 41ft.; depth moulded, 29ft. Engines will be fitted by Messrs. Thos. Richardson and Sons, of Hartlepool, the cylinders being 24, 38, and 64ins. diameter, by 42ins. stroke, with large boilers working at 160lb. pressure.

An Admiralty order has been received at Sheerness Dockyard directing preparation to be made for the construction of a large gunboat of a new type. She is to have a length of 180ft., a breadth of 32ft. 6ins., and a displacement of 960 tons. Her engines are to be of the triple-expansion type, estimated to develop 1400H.P. under forced draught, with a speed of 13·25 knots, and 1050H.P. under natural draught, with a speed of 12·25 knots. Her armament will consist of six 25-pounder and four 3-pounder quick-firing guns.

On the 20th ult. the steamer "Falken," built by Messrs. Craig, Taylor and Co., of Thornaby-on-Tees, was taken to sea for her trial trip, which proved highly satisfactory, a speed of 9½ knots (loaded) being obtained. The vessel is of the following dimensions:—Length, 244ft.; breadth, 34ft.; depth moulded, 17ft. 9ins. The triple-expansion engines, built by the North-Eastern Marine Engineering Company, Sunderland, have cylinders 18½, 30, and 49ins. diameter, by 33ins. stroke. Steam is supplied by two steel boilers capable of working at 160lb. pressure.

The first-class cruiser "Crescent," built in the Portsmouth Dockyards, with engines by Messrs. John Penn and Sons, Greenwich, made a contractors' eight-hours trial of her machinery at Portsmouth on the 18th ult. The mean results at the end of the trial showed a boiler pressure of 152lb., a vacuum of 26·6ins., and 97·9 revolutions. The starboard engine developed 5118H.P., and the port 5252H.P., amounting to a collective indicated horse-power of 10,370. These results were obtained without air pressure, the stokeholds not being closed, and with a coal consumption of 1·18lb. per indicated horse-power per hour. The speed by log amounted to 18·6 knots.

The Relations of Chemistry to Foundry Practice.—II.

Iron.—Chemically pure iron—that is, iron as pure as it can be made—is silver-white in colour, soft, ductile, malleable, and rapidly attacked by oxygen. It forms two principal oxides—ferrous oxide, or iron protoxide, of which the salts are green in colour, and ferric oxide, or iron sesquioxide, of which the salts are yellow. There is a black oxide also, which is a combination of these two oxides. When oxidation of metallic iron takes place rust is formed. There are two kinds of rust. One is yellowish brown, inclining to a reddish hue; the other is black, and tends to form the magnetic oxide. In impure iron the agency of moisture, even in moderately dry air, facilitates this rusting action. The reason of this is that iron decomposes water, which, as you are aware, is composed of the two gases, hydrogen and oxygen. The strong attraction or affinity of iron for oxygen splits up the water into its elements; the oxide of iron, or rust, is formed, and hydrogen is liberated. A clean nail placed in a tumbler of water will show this reaction in a few minutes. Iron may be obtained in a state of purity by reducing the oxide in a current of hydrogen—that is, the oxide is heated to facilitate the action, while a current of pure hydrogen gas is passed over it. Aided by the heat, the hydrogen seizes upon the oxygen, metallic iron is left behind, with water as a bye-product. Under these conditions it is in a finely-divided state, and must be kept from contact with the air, as it is so eager for oxygen that the air sets fire to it, a brilliant flash takes place, and the black magnetic oxide is formed. This phenomenon is familiar about the runners of a blast furnace, or in filling a ladle from a cupola, and frequently on pouring into a mould. The tiny sparks that fly about like little meteors are minute detached particles of iron thrown into the air, which are burned by the oxygen of the air. Iron is not found in the native state on the earth. It is found in meteorites, those peculiar structures which fall to the earth from masses revolving through space when they pass through the field of the earth's attraction. Nickel is always conspicuously associated with it. In some places, notably Greenland, these masses of meteoric iron are of great size. From the readiness with which it is oxidised, dissolved, and reduced, iron forms a great variety of compounds or salts with other chemical reagents. It is indispensable in the arts, in medicine, and in the vegetable world.

Carbon.—Carbon is one of the most remarkable elements which we will discuss. As a solid, it occurs in three distinct forms, bearing no resemblance whatever to each other in outward appearance or physical properties. Colour, specific gravity, hardness, crystalline character, all differ to such an extent as to have no apparent relations. The first form is the diamond. This, the most valuable and beautiful gem in the mineral kingdom, is pure carbon. It is the hardest of all known bodies; is employed for cutting glass, and will scratch the hardest substance. It can only be cut by means of its own dust, and then it has a high refractive power, a ray of light causing it to gleam with brilliant lustre. When burned in oxygen it is found to consist entirely of carbon. The second form of carbon is graphite or plumbago. This is greasy to the touch, so soft that it can be cut by the finger nail, and is very light. Drawn across paper it leaves a black mark, and is hence made into lead pencils. It is also used for lubricating machine bearings and to protect the surface of coarse grains of gunpowder. Pig iron on cooling throws off flakes of graphite, the so-called "kish." The third form of carbon is charcoal. Its purest form is lampblack. When animal or vegetable matter is heated to redness in a closed vessel charcoal is produced. Charcoal carbon also exists as coal, coke and animal charcoal. It is still lighter than either of the two foregoing forms of carbon, and, unlike them, does not crystallise. It has a high absorbing power, which is utilised for the purpose of refining raw sugar, and is valuable as a disinfectant. The wide disparity between these three forms of carbon is evident from the description. Yet on combustion with oxygen each of these yields the same weight of the same substance—namely, carbon. That is, 12 parts by weight of each of these substances yield 44 parts by weight of the resulting compound of carbon with oxygen, carbon dioxide, or, as commonly known, carbonic acid. This metalloid, as we shall see, has a deportment with iron which cannot be supplied to metallurgy by any other element. Its rank in the physical world, animal and vegetable, is so vital that neither plant nor man could exist without it. We burn it in our stoves to get physical heat, and consume it in our bodies to supply the waste of tissue. For the purposes of the metallurgy of iron we win carbon from the earth, where its geological position proclaims it to have been buried for ages.

Silicon.—Silicon is the next element to be considered. After oxygen, silicon is the most abundant element in nature.

It has never been discovered in the free or native state, but by means of a powerful electric arc current it has been reduced from its oxide. Heat more intense than the blast furnace gives, aided by the electrolytic action of the current in the presence of powerful reducing agents, is required to do this. Silicon may be crystalline or amorphous. In nature it occurs as the oxide, or silica, as in quartz, which is crystalline, or as flint, which is dense and hard and sometimes black in colour. Both varieties are sometimes hard enough to scratch glass. Silica is a predominant constituent of all rocks; hence it is found in all kinds of ores, either as silica compounds or as an impurity. In the materials out of which iron is made—ores, fuel, and limestone—it is the largest impurity. The slag which comes from the furnace in the manufacture of iron is therefore a compound of silica; that is, it is a silicate. In consequence of the heat and intense reducing power and volume of the blast furnace, small quantities of silicon are produced, which, in contact with melted iron, combine with it and make a more fusible alloy.

Phosphorus.—As an element, this metalloid enters into the composition of many important bodies. It has been found wherever organic life exists. The oldest rock formations also contain it, usually associated with iron.

Soil, which is produced by the disintegration of rocks, derives in turn its phosphorus from them. Water, air, and the sun decompose even granite rocks, by the familiar action known as "weathering." Plants, and hence their seeds, take up the phosphorus from the soil, and by this process are said to impoverish it. Animals and man absorb from vegetable matter the phosphorus which enters into the composition of their tissues and bones. Phosphorus does not occur in a free state in nature, but in combination with oxygen and calcium. As the former, which is called phosphoric acid or the pentoxide, we thus see that it existed first in the rocks, then by the economy of nature in the soil. Entering the plants, on which animal life subsists, it is transformed into bones, etc., by uniting with calcium oxide, or lime. On burning these it is obtained as calcium phosphate, or phosphate of lime. We are aware that soils are enriched by the use of artificial and naturally-occurring phosphates. Phosphorus is a soft, yellowish, semi-transparent, waxy solid. It absorbs oxygen rapidly, and hence is easily inflammable on exposure to the air. It burns to phosphoric acid or the pentoxide. It is largely used to make a composition for friction matches, and gives to them the "phosphorescence" visible in the dark and a disagreeable, suffocating odour, caused by slow oxidation. Phosphorus is the most persistent element in its association with iron. Apatite and phosphorite are two of its principal forms, which are often separated from the raw ores to purify them for metallurgical purposes. As affecting iron, the greatest ingenuity has been exercised in the control or elimination of phorphorus, since it imparts properties of varying character, which will be described further on in our discussion.

Manganese.—Manganese is a true metal, reddish-white in colour, so brittle that it can be readily powdered, and is so hard that it will scratch glass. It is slightly heavier than iron, and, like that metal, decomposes water at ordinary temperatures, with evolution of hydrogen. It is widely distributed in the mineral kingdom, and is found almost as diversely as iron. It is a common ingredient of iron ores. Metallic manganese is said to be slightly magnetic, but owing to the difficulty of making it chemically pure, this property may be due to presence of iron in minute quantity. It has a strong affinity for oxygen, which it is capable of retaining to such an extent that in the arts its oxides are invaluable. It is not found as a native metal, owing to this susceptibility, but occurs as the various oxides, chiefly as the black dioxide or pyrolusite. This substance when heated alone gives up oxygen, and is hence largely used in making oxygen gas. Manganese forms highly-coloured salts, which are not only useful in making coloured tints in the manufacture of glass, but in making valuable reagents for the chemical laboratory. When manganese is reduced from its ores in a blast furnace it is found to unite with carbon and silicon in much the same manner as iron, and can be made into a product containing iron, called spiegeleisen or "spiegel," or a variety called ferro-manganese, which may contain 80 per cent. by weight of metallic manganese. These two alloys are used in the manufacture of steel by the Bessemer process. Manganese is an extremely useful element, and, as we shall see, has important effects upon the properties of cast iron.

(*To be continued.*)

Notices of New Books.

THE MECHANICAL ENGINEER'S POCKET-BOOK OF TABLES, FORMULÆ, RULES, AND DATA. By D. KINNEAR CLARK. London: Crosby Lockwood and Son.—A MANUAL OF RULES, TABLES, AND DATA FOR MECHANICAL ENGINEERS. By D. K. CLARK. London: Blackie and Son.

WE are inclined to think that no one has laboured more assiduously in collecting rules and data for the mechanical engineer than Mr. D. K. Clark. Certainly no one has so well succeeded in meeting the requirements of the profession in this particular direction, as the increasing demand for these works of reference proves very conclusively. Scarcely more than twelve months after the appearance of the first edition of the "Mechanical Engineer's Pocket-book," another edition of the work has been called for, and opportunity has therefore been afforded to revise the text, as well as to introduce much new matter. New tables are given of the strength of rolled steel joists and of steel compound girders; change-wheels for screw-cutting lathes; pitch-line diameters of toothed wheels; wheels for dividing wheels; notes on milling, hydraulic machine tools, etc. In a pocket-book of this kind it is always difficult to decide what to include and what to omit, but for all-round general utility we do not think Mr. Clark's selection can well be improved upon. We feel confident that the time-honoured "Molesworth" will be quite superseded by this excellent pocket companion.

Mr. Clark's voluminous "Manual of Rules, Tables, and Data" is so well known as a standard work of reference that detailed comment on our part is needless. The work is now in the sixth edition, and has been kept thoroughly up to date in every respect. This work is well-nigh invaluable in all calculations and estimates relating to the strength of materials; heat and steam; combustion and fuels; steam boilers and engines; hot-air and gas engines; hydraulic machinery; mill gearing; weights, measures and moneys, etc. The very complete and exceedingly well-arranged mathematical tables comprise not the least valuable portion of this excellent work. Without Mr. Clark's manual, we may truly say no engineer's library can be considered complete.

THE ELEMENTS OF GRAPHIC STATICS: A TEXT-BOOK FOR STUDENTS OF ENGINEERING. By L. M. HOSKINS. London: Macmillan and Co.

THE comparatively recent and rapid development of that branch of mechanics known as graphic statics has led to the production of a number of treatises on the subject, which, for the most part, however, have not met the requirements of the elementary student of engineering construction. As a rule, they deal with the subject in a manner which disheartens those students who are not adept mathematicians; and, as a matter of fact, until recently we knew of no good elementary work on this subject which we could recommend to students. Mr. Hoskins has, however, quite removed our difficulty, for he has provided a capital text-book on the subject, which appears to us to be admirably adapted to the requirements of the elementary student. The matter treated has been limited to the development of fundamental principles, and their application to the solution of typical problems. The method of the force and funicular polygons is deduced from statical principles, and the geometrical theory of reciprocal figures is only considered to a small degree. The book is primarily divided into three parts, the first dealing with general theory, the second with stresses on simple structures, and the third with centroids and moments of inertia. A capital system of lettering has been adopted for indicating corresponding lines in force and space diagrams, and the illustrations are executed in excellent style, especially the five folding plates at the end of the work. We have pleasure in directing attention to Professor Hoskins' treatise, as it is undoubtedly one of the best books on the subject yet written. The name of the publishers is a sufficient guarantee of the typographical excellence of the production.

STANDARD TABLES FOR ELECTRIC WIREMEN. By CHARLES M. DAVIS. New York: W. J. Johnston and Co. Limited.

INTO the third edition of this popular little book much new matter has been introduced, and the wiring tables have all been recalculated on a uniform basis and arranged in a convenient manner for practical use. The instructions for wiremen and linemen are plain and straightforward, and the rules for safe wiring, as well as the diagrams of circuits, are presented in a manner that renders them easily understood. The book also contains much useful data on electrical work, and will be found a very serviceable pocket companion by those for whom it has been more especially prepared.

Trade Notes.

The West of Scotland Sugar Plant and Engineering Company are erecting works at Motherwell.

The Steel Company of Scotland have just booked an order for 5000 tons of steel rails for a local railway.

Messrs. Aveling and Porter, of Rochester, have obtained an order from the Middleton Corporation for a 10-ton steam road roller.

Messrs. Neilson and Co., of Glasgow, have contracted to make nine tank and six bogey engines for the Great North of Scotland Railway.

Messrs. Wrightson and Co., Teesdale Ironworks, Stockton, are constructing a new floating hospital for the Tees Port Sanitary Authority.

Messrs. Dubs and Co., Polmadie Locomotive Works, Glasgow, have booked an order from the Finland State Railway for five express passenger locomotives.

Messrs. R. and J. Dempster, of Newton Heath, have been awarded the Irvine Commissioners' contract for a new gasholder to contain 86,000ft., at a cost of £9197.

The directors of Messrs. Ruston, Proctor and Co. announce the payment of a dividend of 10s. per share, making, with the interim dividend, 7½ per cent. for the year.

The Great North of Scotland Railway Company have placed an order for 100 passenger carriages with the Ashbury Railway Carriage and Iron Company, Openshaw, Manchester.

The Marshall Car Wheel and Foundry Company, of Marshall, Texas, are about to establish a large works at Houston, Texas, for the manufacture of car wheels and general railway castings.

Messrs. Richards and Co., axle manufacturers, have removed from Eagle Works, Queen-street, Wednesbury, to entirely new premises which have been erected for them in Hobbins-street, in the same town.

The Great Northern Railway Company have accepted the tender of Messrs. Johnson and Phillips, of London, for the supply of Brockie-Pell arc lamps and accessories for their Holloway electric-light station.

The Grusonwerk, Buckau, Magdeburg, with all its assets and liabilities, have been bought up by Messrs. Fried. Krupp, Essen, and the works will be carried on in future under the style of Fried. Krupp Grusonwerk.

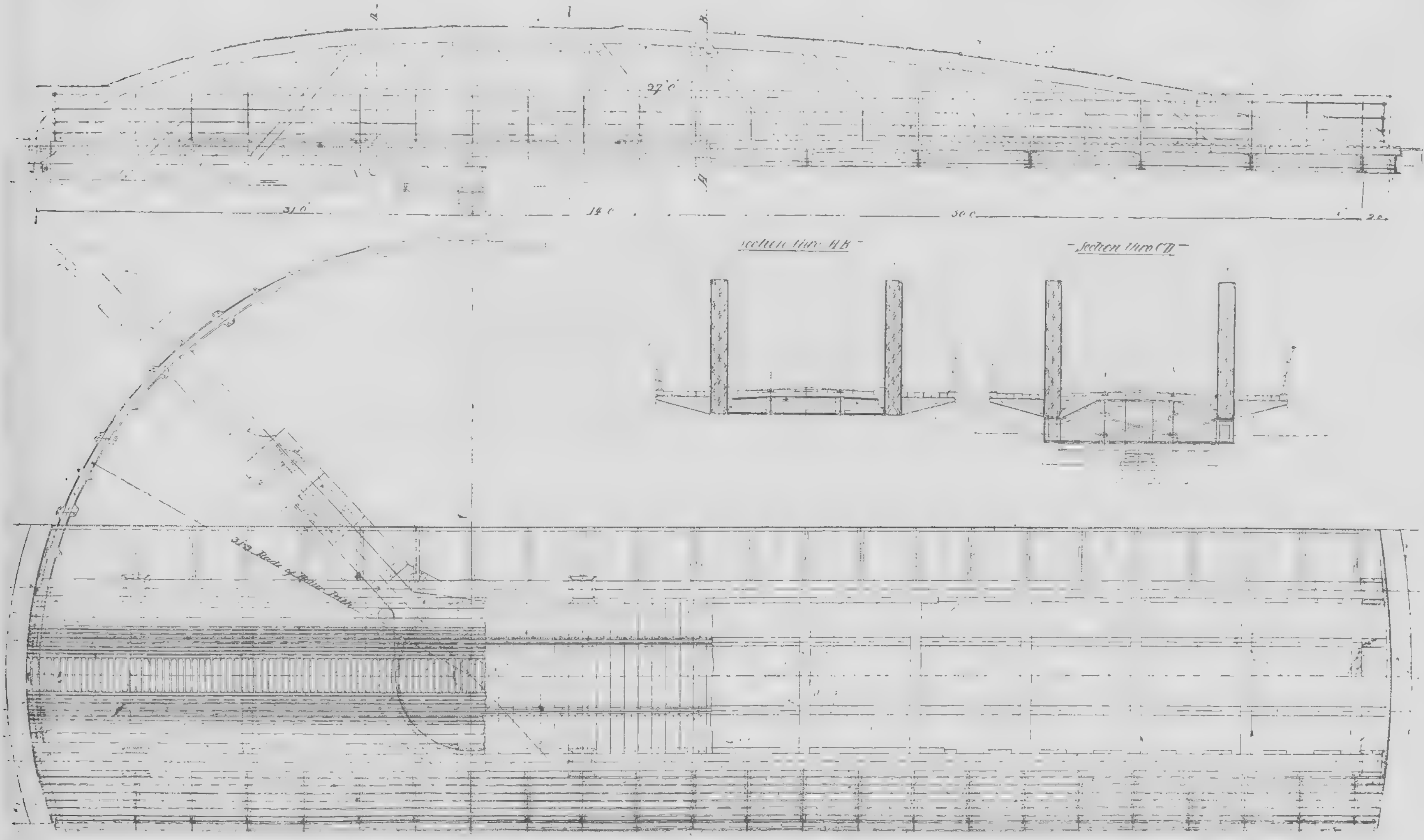
The Birtley Iron Company have contracted to supply and erect the pumping engines and appliances for the new pumping station at Seaham Harbour, belonging to the Sunderland and South Shields Water Company.

The directors of Messrs. Richard Hornsby and Sons, engineers, Grantham, have declared interim dividends on the ordinary shares of 2s. 6d. per share for the half-year ended March 31, and on the preference stock at the rate of 6 per cent. for the half-year ending June 15.

The fifth annual report of the directors of the Whitehaven Hematite Iron and Steel Company shows a profit of £3127, which raises the balance at the credit of profit and loss account to £22,058. No dividend will be proposed, but £5000 will be devoted to the establishment of a depreciation fund, and the balance of £17,058 carried forward.

Hydraulic Machinery.—XV.

THIS series of papers on this subject must draw to a close, for although we have only touched upon one or two of the principal machines, the general principles are the same throughout.



HYDRAULIC MACHINERY.—FIG. 44.

Fig. 44 shows an arrangement of a swing bridge for a 50ft. lock. The bridge is made up of two unequal arms. From the centre pivot to the nose end is 66ft., and to the tail end 31ft., making up a total length of 97ft. The width is 12ft. 6ins. between the centres of the main girders, and the footpath projects 4ft. 6ins. beyond the centre of the girders on either side. The tail end is balanced with cast-iron kentledge weights, so as when lifting to give a preponderance of about 4 tons on the rollers. The rollers are of cast iron, coned to run out at the centre of the pivot, and they are chilled on the surface. The roller path is cast iron, chilled on the surface, and has angle joints to allow the roller to pass gradually, and without jar. A series of cast-iron resting blocks are provided to carry the bridge when at rest either across the lock or open. The hydraulic machinery to work the bridge consists of a centre lifting press with ram and pivot bearing, as shown in Fig. 45, and two hydraulic turning cylinders with the necessary rams, sheaves, and guide sheaves and turning drum complete. A lifting and lowering valve, generally of the spindle type, is used to work the press, and an ordinary turning valve as used in cranes to work the turning cylinders. To work the bridge, pressure is admitted into the lifting press and the bridge lifted off the resting blocks; pressure is then admitted to the turning cylinders and the bridge turned in either direction as may be required. A similar type of bridge to the above is often made with the roller path inverted, so as to reduce the weight of the kentledge. A section of the roller path, which is the only portion altered, is shown in Fig. 46.

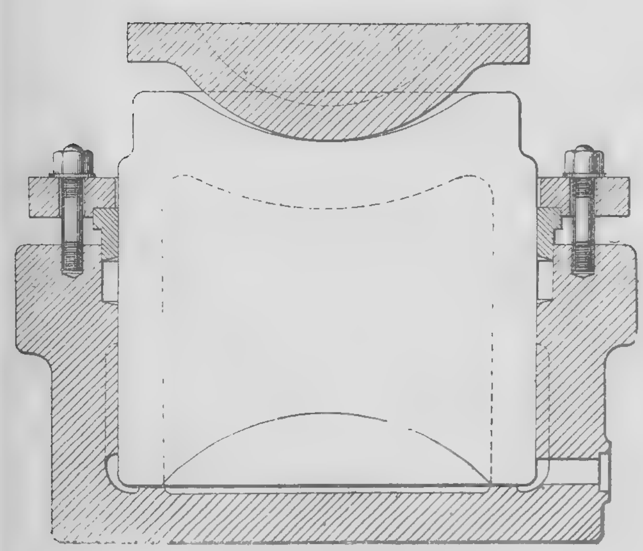


FIG. 45.

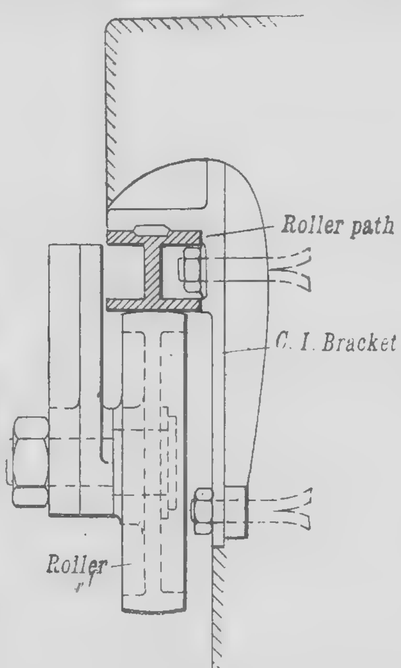


FIG. 46.—HYDRAULIC MACHINERY.

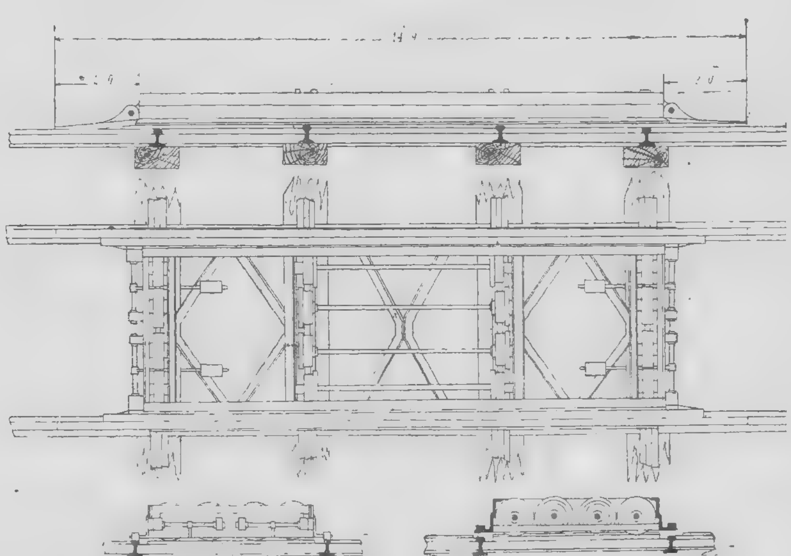


FIG. 47

For larger bridges, such as the swing bridge over the Tyne, a separate engine, boiler, and accumulator are fitted in the centre pier, and work a hydraulic engine which is geared into a rack fitted on the underside of the main girders; a ring of live rollers is inserted between the roller paths to reduce the friction, and hydraulic locking gear and lifting presses are also provided. The Tyne bridge has equal arms, and in opening makes a quarter turn to the centre pier, and as the vessel passes through, follows in behind, making a half revolution in the same direction to open and close.

The lifting cylinder for a swing bridge is calculated as a lifting cylinder by the ordinary rule; but in addition to the weight of the bridge due allowance must be made for the moisture which will be absorbed by the roadway, especially if of wood, in wet weather. The resistances to the turning are the frictions of the roller path and of the pivot, and the resistance of the wind.

Another useful hydraulic machine is the traverser, as used in railway goods stations for conveying trucks from one line of rails to another without the use of turntables. A traverser bogie is shown in Fig. 47. It consists of a wrought-iron frame with oblong rails on the sides, and slippers for aiding the transfer of the carriage or truck on to the traverser. These slippers are balanced so that immediately the truck passes them they rise up clear of the rails and allow the traverser to be taken across on to another line. The hydraulic hauling gear consists generally of two cylinders with multiplying sheaves similar to those shown in the gate machine (Fig. 43). Grooves are cut in the rails to allow the traverser wheels to pass, and also for the hauling chain. In many of the Continental stations the traverser bogie as shown is used without the hydraulic power, horses being used to pull it from one line of rails to another.

The other uses for which hydraulic power is adopted are too numerous to be detailed, but amongst others may be mentioned hydraulic presses, hydraulic machine tools, and the hydraulic apparatus for dealing with heavy ordnance, as amongst the most important, all three forming special branches of hydraulic engineering.

Another branch which is yet comparatively in its infancy is hydraulic machinery for ships, but which is likely to develop,

especially in large passenger steamers, where the noiseless working of the hydraulic cranes and steering gear adds greatly to the comfort of those on board; and also by the use of the hydraulic reversing gear, owing to the ease with which the engines may be manipulated.

New developments are constantly taking place, and hydraulic buffers, turntables, machinery for working railway signals, points and interlocking gear, are proposed. In gasworks we shall soon be familiar with hydraulic charging and drawing machines for the retorts; while for every new contract we have only to look at the pages of our engineering journals to realise the importance of the branch of engineering we have been considering in these papers.

(Concluded.)

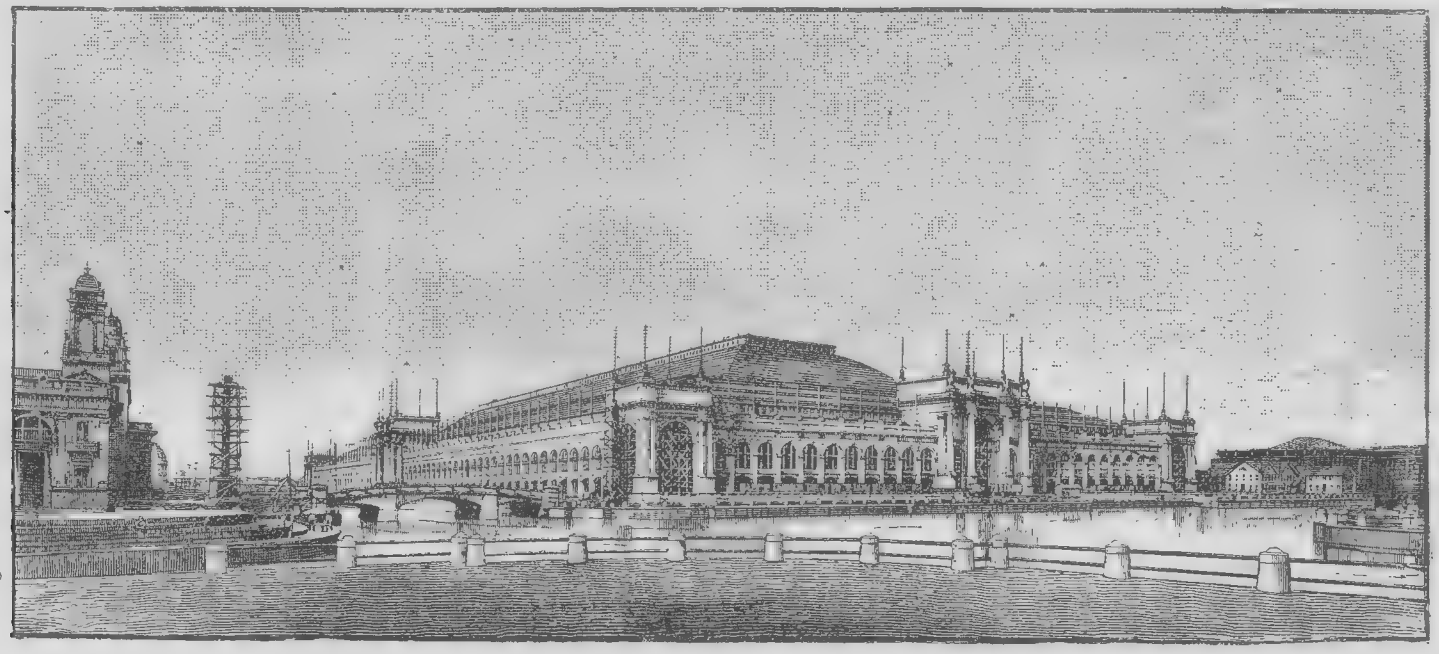
The Chicago Exhibition.—I.

THE Chicago Exhibition—or, to be euphemistic, the World's Columbian Exposition of 1893—resembles, in at least one respect, the exhibitions of previous years, inasmuch as it is as yet far from being complete in any sense of the word. Statements have appeared in the daily press to the effect that the Americans themselves are the most backward in this respect, but we are advised that so far as the British exhibits in the Machinery Hall are concerned, things are in a very backward state. The high-speed engines which are to drive a large portion of the shafting have only recently arrived, and are now being erected under difficulties, as no crane is available.

We may here state that we have sent a special representative to Chicago, who is fully competent to critically examine and describe the various exhibits which are of interest to the readers of THE MECHANICAL WORLD. We shall, therefore, be enabled to present from time to time illustrations and descriptions of the more noteworthy exhibits of engines, boilers, tools, and machinery in general which are to be found at the great Chicago World's Fair.

THE MANUFACTURES AND LIBERAL ARTS BUILDING.

While we do not intend to give illustrations of the various buildings and structures which compose the Exhibition, we cannot omit a brief reference to two of the most important and most interesting of these. The Manufactures and Liberal Arts Building (Fig. 1) is not only the largest structure in the Exhibition, but it is also the largest covered area in the world. The roof covers an actual area of 30½ acres, while if the upper galleries are included the area aggregates over 40 acres. The single span of the roof is 368ft. wide and 206ft. high, and this is surrounded by side galleries with comparatively narrow roofs. The length of the central portion of the building is 1268ft. The roof is supported by 18 principal girders spaced 50ft. apart. It should be added that the whole floor of the building was laid before the structure was erected.



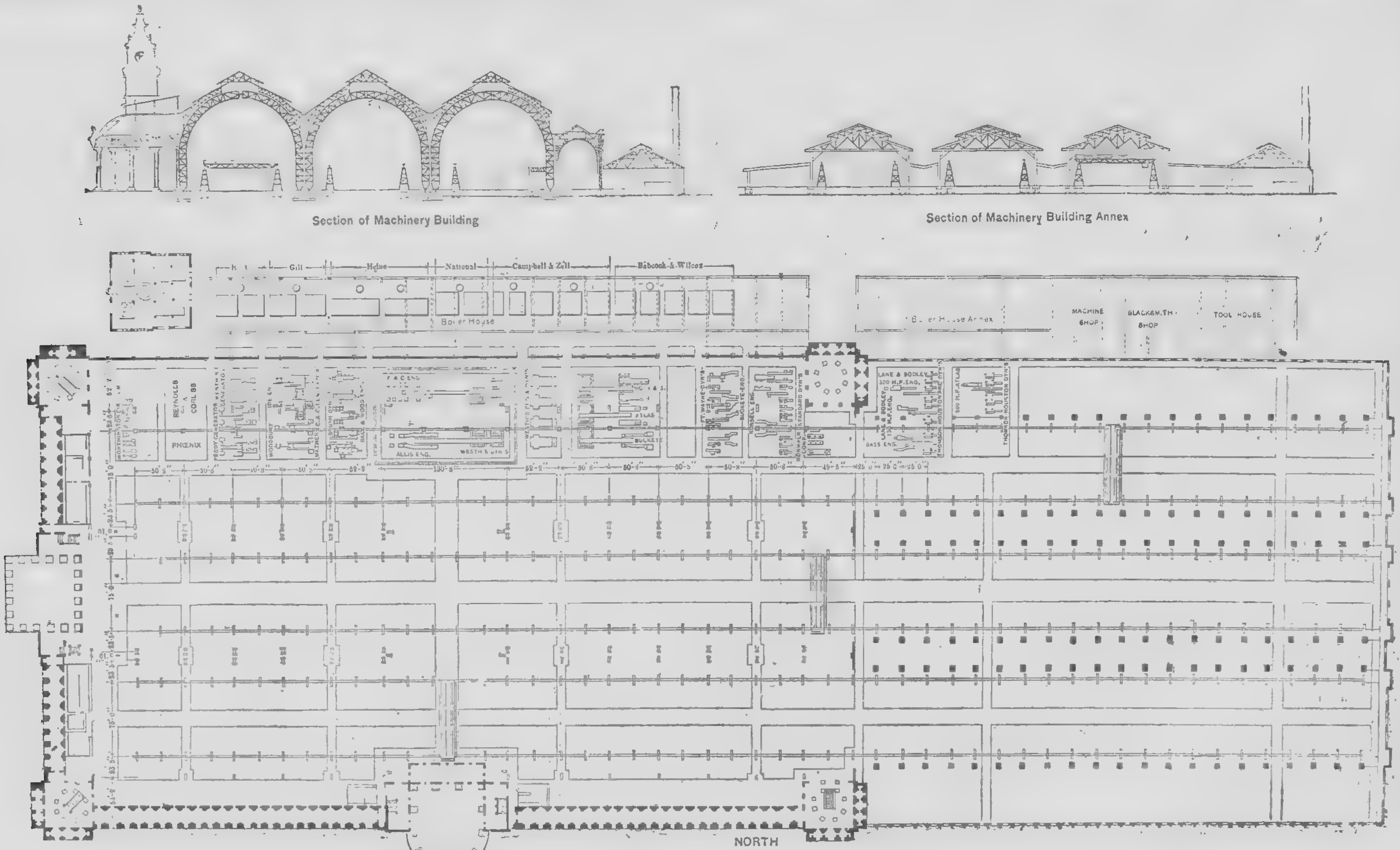
CHICAGO EXHIBITION.—FIG. 1: THE MANUFACTURES AND LIBERAL ARTS BUILDING.

THE MACHINERY HALL.

The Machinery Hall—or, as it is variously termed, the Mechanical Arts Building, or the Palace of Machine Arts—is 850ft. long, 500ft. wide, and has an annexe 500ft. long by 550ft. wide at one end. The general arrangement will be gathered from Fig. 2. The three main galleries shown in the section of the machinery building are 130ft. wide. A 50ft. gallery surrounds the building on all four sides, the roofs of which are semi-circular. Elevated travelling cranes running from end to end of the hall are supplied for placing and moving the machinery.

In Fig. 2 is given a plan and sectional views of the hall and annexe and the location of the power plants, consisting of different kinds of engines, boilers, electric generators, etc., the positions of which are plainly marked on the plan. These power installations will be of all sizes, ranging from those of a few horse-power up to 2000H.P. It is designed to have 30,000H.P. of steam machinery in operation in this building. Power is supplied for about 14 hours per day.

(To be continued.)



CHICAGO EXHIBITION.—FIG. 2: PLAN OF THE MACHINERY HALL.

HITHERTO, if copper or other metal is to be deposited electrically, a bath of solution has been needed. Now this is all changed, and a ship's hull can be plated as easily as a spoon or teapot. Instead of a bath we are to have insoluble salts, ground to a fine powder, and mixed with water. This is painted on the metal to be plated by a fine wire brush, to which one pole of a dynamo conductor is attached, the other pole being connected to a plate. Not only pure metal, but all sorts of alloys can be used. Aluminium can be so plated, it is said, with silver or gold.

THE quantity of mineral oils from the wells of the Caspian now shipped annually from Batoum reaches the enormous amount of 931,328 tons, or about 3000 tons for every working day of the year, representing a total value at the port of nearly 3½ millions sterling. Nearly one-third of this vast total is shipped to ports east of the Suez Canal. The annual returns exhibit, moreover, a constant increase, the exports of last year being 63,633 tons in excess of those of the previous year.

The Iron and Steel Institute.

A LARGE number of members attended the spring meeting of the Iron and Steel Institute, held on Wednesday and Thursday of last week in the hall of the Institution of Civil Engineers, Westminster. Sir Frederick Abel, K.C.B., the retiring President, occupied the chair during the transaction of the formal business, after which the new President, Mr. E. Windsor Richards, of Low Moor, took the chair and delivered his address, a short abstract of which is given below. At the conclusion of the address, Sir Lowthian Bell received, on behalf of Mr. John Fritz, of Bethlehem, Pa., U.S., the Bessemer Gold Medal for 1893, the latter being unable to be present to receive the medal personally. The President, in giving a short biographical sketch of Mr. Fritz, observed that the latter was one of the small band of leaders who had so successfully developed the Bessemer process in the United States, and had astonished the metallurgical world by the enormous quantities of steel produced from comparatively small plants. Mr. Fritz had during the past few years, in conjunction with Lieut. Jaques, designed, constructed and managed one of the most important armour-plate plants and gun-making works in the world, producing the highest qualities of open-hearth steel. The highest honour the Institute could confer upon him was the presentation of the Bessemer Gold Medal.

A PRACTICAL REVIEW OF METALLURGICAL DEVELOPMENTS.

In the course of his address the President said that he would confine his remarks to practical points, reviewing some of the developments in the metallurgical operations of iron and steel works. The meeting, he observed, was held under circumstances of great depression for the iron and steel trades, last year having been in many respects the worst those industries had ever known. The production of pig iron diminished by over 600,000 tons, and that of wrought iron and steel was much below that of some previous years; but the most serious falling off was in the output of steel rails. In fact, the total diminution in our exports of metals and machinery during 1892 as compared with 1891, amounted to over £7,000,000. A feature of the iron industry last year was the great falling off in the quantity of pig iron made from English ores, whilst the consumption of imported ores greatly increased. It was generally thought that the most valuable and extensive deposits of ore in Spain were rapidly being exhausted, and the question arose whether, if those supplies were cut off, we could depend wholly upon our home mines. He believed that we could, and that if foreign supplies ceased the prejudice against the use of steel made by the basic process would doubtless quickly disappear; and this would lead to the greater use of phosphoric ironstone, and, of course, of the ore free from phosphorus existing in this country.

Blast-furnace Practice.—After referring to the recent visit of the Institute to America, the President observed that as the blast-furnace power of this country was far in advance of the demand for pig iron, our attention had been more directed to economical working than to large yields. At Eston, Messrs. Bolckow, Vaughan and Co. erected plant in 1877 which, with a 50 per cent. ore, turned out 1000 tons of hot blast pig iron per week in one furnace; and at the new works of the Dowlais Company, at Cardiff, one furnace produced 1400 tons a week, using the usual Rubio ore, and with less than 20cwt. of coke per ton of pig iron, 70 per cent. of the output being No. 1 quality. This large production had necessitated the introduction of mechanical means to rapidly remove the pig iron from the beds, where it was allowed to become cold, to break it up and reduce the cost of labour. The apparatus consisted of quick-running overhead steam travelling cranes, which swept the whole surface of the pig beds. The breaker was fixed at the far end of the line of furnaces. It was important that the pigs should be moulded at equal distances apart, and means were devised for ensuring this so that the three fixed hammers on the hydraulic rams might exactly suit the distances of three pigs. The beds, being thus moulded, were cast in groups of thirty pigs, which were not meddled with until cool. The overhead crane then picked up the whole group of thirty pigs, and ran with it at a high speed to the breaker, depositing it on a light four-wheeled carriage running on an incline towards the breaker, thus enabling the workmen to push forward easily the loaded carriage. On arrival, the group was drawn forward by a pawl of sufficient length of stroke to place the group of pigs under the hydraulic ram, which at one stroke broke three pigs, though only one at a time, the sow being broken by a second ram. The four pieces of broken pig slid down a strong shoot into a railway wagon, the detached sand falling between the bars forming the shoot. One machine could in this way readily deal with 4000 tons of pig iron weekly, working from eight to ten hours daily. The total cost of those operations was 1½d. per ton.

Cold-blast Furnaces.—Coming to consider cold blast furnaces, he mentioned that the No. 1 furnace at Low Moor was put in operation over a century ago, the output ranging from 75 to 80 tons per week. That had recently been superseded by one which was probably the largest yet constructed. It was 70ft. high; boss, 18ft. diameter; hearth, 9ft.; throat, 15ft.; bell, 11ft.; capacity of furnace, 10,700 cub. ft. There were two calcining kilns, two single high-pressure non-condensing blast engines, and four Lancashire boilers. With one engine at work, making 28 revolutions per minute, 4lb. pressure of blast, and three tuyères with 4in. muzzles, an output of 350 tons per week of grey iron was attained, the quantity of blast at atmospheric pressure being 10,000 cub. ft. per minute. The coke per ton of pig was 38cwt., and the Better Bed coal of the district was exclusively used for pig-iron making. The ironstone, which was directly above, and was worked with the Black Bed coal, contained 30 per cent. of iron in the raw state and about 42 per cent. calcined, 3⅓ tons of raw stone being required to make a ton of pig iron. There was no doubt that a blast furnace, in order to work well and give a regular quality of pig iron, should be worked at a fairly fast rate of driving; and it was also certain that the amount of iron produced depended upon the quantity and pressure of the blast driven in. The speed at which a furnace should be driven could only be determined by experiment, but the furnace in question worked far better when making 350 tons per week than it did when producing 200 tons.

Manufactured Iron.—With regard to manufactured iron, he said that the puddler was not yet dead, as was shown by the production last year of 1,500,000 tons of puddled bars. In speaking of best Yorkshire iron, he was only able to describe from personal knowledge the process of manufacture at Low Moor, where *really cold-blast* pig iron had always been exclusively made. It contained from 1 to 1¼ per cent. silicon and 0·3 per cent. of phosphorus. The whole of the pig iron was passed through the refining process, no pig iron being puddled. The refinery eliminated the whole of the silicon and reduced the phosphorus to one-tenth by constant practice with materials of very slight variation, the refiner knowing how to leave the carbon untouched. The puddlers therefore had only to eliminate carbon and the small remaining quantity of phosphorus, in order to obtain a practically pure lump of iron. The puddler worked ten heats of refined metal of 3cwt. each per turn. The puddled balls were all worked under 50cwt. steam hammers into slabs about 12 × 10 of varying thickness. These slabs were then piled and repiled to make the required weight for rolling into the various sizes of finished iron, whether plates or bars. All these weldings required the greatest care in heating and hammering; and the iron bore a very high heat without any deterioration of quality. In plate rolling, the greatest care, too, had to be taken to avoid laminations and blisters; the purer the iron, the more difficult it seemed to be to prevent them. Careful examination was made when rolling by having jets of water playing on the surface of the plates to detect blisters or unwelded portions. The inspection was continued when the plate was cold by rapping all over both surfaces with a hammer, and noting the sheared edges all around the plates. The result of all this care, skill, and good materials, was a soft, ductile and reliable iron. The speaker then referred to some recent tests undertaken by Professor Arnold with wrought iron.

Siemens-Martin Furnaces and Plate Rolling.—In dealing with Siemens-Martin furnaces and plate rolling, the President mentioned that whereas in 1880 there were 126 open-hearth melting furnaces, producing 251,000 tons of ingots a year, in 1890 the number had increased to 320, with an output of 1,564,200 tons, and in 1892 to 359, and was still increasing. The capacities of furnaces had been gradually raised until some had given as much as 40 tons of steel at a cast, but a more convenient size for all-round work had a capacity of from 20 to 25 tons. The construction and form of the furnace itself was generally much as it was left by Sir William Siemens. A valuable improvement was made by Mr. J. Riley, in conjunction with Mr. Dick, when he separated the regenerative chambers from the furnace; but the most successful advance was made a few years ago by the former in the general arrangement of handling and dealing with the molten metal till it was converted into a finished plate, without reheating the ingot. In this case the molten metal was received in a travelling ladle from each furnace, and then conveyed by a locomotive to a convenient position, where the operation of teeming the ingots was conducted in comparative comfort. When the ladle arrived at its destination it was lifted off its trunnions by a hydraulic apparatus, and the metal repoured into a second ladle mounted on a hydraulic centre casting crane of 20ft. radius, the object of the repouring being to obtain a uniform steel by the more thorough combination of the alloys of carbon, manganese, and iron. After casting the ingots were lifted out of the moulds by cranes, placed for two and a half hours in Gjer's soaking pits, conveyed by mechanical arrangements to the cogging mill—where, by successive to-and-fro passes, the ingots were reduced to slabs of a thickness suited to the plates into which they were afterwards to be rolled—and cut up under hydraulic shears. They were then conveyed by mechanical means to the reheating furnaces and rolled either in a two-high reversing train, or in a three-high mill, having the centre roll of smallest diameter.

Bessemer Converters and Rail Rolling.—Treating of Bessemer converters and rail rolling, he remarked that the largest production of ingots (2,140,000 tons) was in 1889, and the largest output of rails (1,235,785 tons) in 1882. Although there were 108 Bessemer converters in the country, only 1,510,810 tons of ingots, and 535,836 tons of rails were made last year. The steel trade being even in a more stagnant position this year than last, there was no scope for the energy of our steel-makers, and they were unable to show any satisfactory results of output, or any great improvements in construction or arrangement of plant. It was impossible, with all the knowledge of blast-furnace working, to obtain a uniform quality of iron. Ladles of iron taken direct from the blast furnace sometimes varied considerably, especially in the percentage of silicon. Captain Jones had, however, constructed a reservoir termed a "mixer," which would hold 100 tons of molten metal, with the view of equalising the quality of the iron used by mixing iron from several furnaces and from several casts. Two of those mixers had been built at Eston, and had given greatly improved results. He then referred to the Bessemer steel plant at Scranton, Pa., where the system of rolling used by Messrs. Bolckow, Vaughan and Co. had been adopted.

In conclusion, the President stated that so successful had they all been in economically increasing production that they had inundated and swamped the markets for the time being, and that at present, and for some time past, there was not enough work for half the steel-producing power of the country. New markets were looked for in vain, and no one seemed to be able to answer the question as to where the trade was to come from to keep the workmen employed and the establishments in operation. Many serious depressions had previously taken place, though none seemed so deep, so prolonged, as the present. There was, however, left to the iron and steel trades that inestimable blessing—hope.

(To be continued.)

Society of Engineers.

THE next ordinary meeting of this society will be held at the Town Hall, Westminster, on Monday, the 5th June, when a paper will be read on "Economical Hydraulic Lifts," by Mr. Robert Carey, of which the following is a synopsis:—General description of various kinds of lifts; lifts: hand-power, power, electric, and hydraulic; safety appliances; entrance doors automatically opened; inspection of lifts by Government expert; water-saving lifts; multiple power machines; modes of automatically adjusting power to suit load; actual quantity of pressure water saved; extra safety obtained; modern suspended lift.

Metal Trade Memoranda.

The Jersey Tinplate Works at Briton Ferry have restarted after several weeks' idleness.

There were 266,560 tons of pig iron produced in South Russia during 1892, being 27,200 tons more than in the preceding year.

The production of gold in British Guiana during the first quarter of this year amounted to 24,470oz., as compared with 21,770oz. in the corresponding period of last year.

Messrs. Taylor and Farley, West Bromwich, have just cast an immense roll weighing over 26 tons. It was ordered for one of the leading armour-plate works in another town.

The annual report of the American Iron and Steel Association states that last year the production of pig iron was 9,157,000 gross tons, as compared with 8,279,870 tons in 1891, and 9,202,703 tons in 1890. In 1892 Bessemer steel ingots were produced to the extent of 4,168,435 tons, open-hearth steel 669,889 tons, and rails 1,551,844 tons.

The number of furnaces in blast in Belgium at the commencement of May was 25; the number of furnaces out of blast at the same date was 22. The production of pig in April amounted to 62,250 tons, as compared with 58,050 tons in April, 1892. The aggregate production of pig in the first four months of this year amounted to 252,540 tons, as compared with 244,145 tons in the corresponding period of 1892.

On the 27th ult. the return of Mr. Waterhouse to the Northern Conciliation Board for the manufactured iron and steel trades was presented for March and April. The average selling price of rails, plates, bars, and angles was £4 19s. 11d. This being a reduction of 1s. 3d. only on the January and February ascertainment, wages are not reduced on the sliding scale, being still 7½ per cent. above the minimum. The production, 23,700 tons, is, owing to depressed trade, little more than half that of two years since, the output then being 43,000 tons.

New Companies.

STANDARD PISTON RING AND ENGINEERING COMPANY LIMITED.—This company was registered on the 20th ult., with a capital of £2000, in £10 shares, to carry on the business of piston-ring manufacturers, mechanical engineers, etc. The number of directors is not to be less than 3, nor more than 5; qualification, 10 shares; remuneration to be fixed in general meeting. Registered by T. A. Peck, 3, George-street, Sheffield, solicitor.

WALTER W. SMITH AND CO. LIMITED.—This company was registered on the 20th ult., with a capital of £7500, in £1 shares, to enter into a certain agreement to acquire the business of W. W. Smith and Simmons, and to carry on the business of mechanical engineers and manufacturers of mats, rugs, lubricators for railway and other carriages. The first directors are H. S. Murray Graham, W. B. Hemans, and W. W. Smith; qualification, £250. Registered office, Priory Works, High-road, Clapton, N.E.

MYERS SCREW PROPELLER SYNDICATE LIMITED.—This company was registered on the 19th ult., with a capital of £25,000, in £5 shares, to carry into effect a certain agreement made on the 16th ult., between Charles Myers and others; to apply for patents, etc., exclusively to be of advantage to the company; and to carry on the business of mechanical engineers, ironfounders, etc. The following gentlemen have been appointed the first directors of the company:—Charles Myers, J. Gray Farrar-Morgan, and John Louden; remuneration, £1000. Registered by Field, Roscoe and Co., 36, Lincoln's Inn Fields.

TYNESIDE ENGINEERING, SHIPBUILDING, AND REPAIRING COMPANY LIMITED.—This company was registered on the 20th ult., with a capital of £25,000, in £10 shares, to carry out a contract made on February 13 last, between T. F. Wilson and J. R. Lawson (the younger), for the purchase of freehold premises situated in Wapping-street, South Shields, known as Stainton's Foundry; and to carry on the businesses of shipowners, engineers, etc. Five of the above subscribers are to be the first directors of the company; qualification, 40 shares; remuneration to be yet fixed. Registered office (for temporary purposes only), 3, Ocean-road, South Shields.

The Metal Market.

PRICES CURRENT.

LONDON, May 29.

COPPER opened easy with business at £43 cash, but sharply dropped to £43 10s. three months, at which a fair quantity changed hands. The market then became slow and drooping, one month passing at £43 2s. 6d., but cash was steadily held and made £42 18s. 9d. Later, however, £42 17s. 6d. was taken, and £43 7s. 6d. three months, and after the official close £43 6s. 3d. three months and £42 16s. 3d. cash were accepted, but, on buying to cover, cash finally rallied to £42 17s. 6d., the close being quiet at 2s. 6d. to 5s. decline. Sales, 700 tons. Settlement price, £42 15s. English tough, £46 to £46 5s.; best selected, £46 15s. to £48; strong sheets, £55.

TIN opened with holders asking higher prices, but buyers were indifferent, and after cash business at £86 17s. 6d. Penang and Straits cash sold at £86 15s. Later £86 10s. was accepted for the latter description, and £85 15s. for the middle of June, with holders clearing out. Cash was offered at £86 2s. 6d. before the first session closed, and £86 was accepted in the afternoon, the close, being easy at 20s. decline on the day for cash, and 5s. for three months. Sales, 80 tons. Settlement price, £86; English ingots, £89 10s.

PIG IRON opened dull, with Scotch cash sellers at 40s. 6d.; and, although there was more inquiry later in the day, no business was recorded, the market closing with buyers at previous quotations, and sellers at ½d. more. Middlesbrough closed 1d. to 1½d. and hematite ½d. better. Settlement prices:—Scotch, 40s. 6d.; Middlesbrough, 33s. 11d.; hematite, 44s. 8d.

TINPLATES are dull and unchanged. I.C. cokes, f.o.b. Swansea, 11s. 6d. to 11s. 7½d.

LEAD opened steady, with business at £9 10s., but towards the close £9 8s. 9d. was accepted, and there were sellers over at the close. English, £9 10s. to £9 11s. 3d.

SPELTER has ruled firm, with business at £17 15s. for June shipment, and closed with buyers at this figure.

ZINC SHEETS.—Silesian quiet and unchanged at £20 10s. ex ship. Belgian steady, the V.M. brand at £21 5s. ex ship and £21 2s. 6d. f.o.b. Antwerp.

OFFICIAL CLOSING QUOTATIONS.

	To-day. £ s. d.	£ s. d.
COPPER—		
G. M. B.—Cash	42 16 3	—43 3 9
„ Three months	43 7 6	—43 15 0
TIN—		
Fine foreign—Cash	86 0 0	—86 10 0
„ „ Three months	84 10 0	—85 0 0
Australian—Cash	86 10 0	—87 0 0

PIG IRON—

	Scotch. Cash. s. d.	Scotch. 1 m'th. s. d.	Middlesbrough. Cash. s. d.	Middlesbrough. 1 m'th. s. d.	Hematite. Cash. s. d.	Hematite. 1 m'th. s. d.
Close	40 6	40 8½	33 11	34 1½	44 8	44 10½
Prev. close	40 5	40 8	33 10	34 0	44 7½	44 10

GLASGOW, May 29.—The pig-iron market was quiet but firm. Some 5000 tons Scotch sold at the forenoon market, and the price was easier, buyers retiring to 40s. 5d. At the afternoon market there was no pressure of sales, and on a slight demand the cash quotation rallied to 40s. 6½d. About 10,000 tons changed hands. Cleveland was firm, and one lot brought 34s. cash, being 2d. advance on Friday's finish. Hematite again quite neglected. The Scotch shipments last week were 7182 tons, an increase on the corresponding week of 1561 tons, making an increase this year of 1981 tons.

QUOTATIONS:—

	Scotch. Cash. s. d.	Scotch. 1 m'th. s. d.	Middlesbrough. Cash. s. d.	Middlesbrough. 1 m'th. s. d.	Hematite. Cash. s. d.	Hematite. 1 m'th. s. d.
Highest	40 6½	40 9	34 0	34 2½	44 8	44 10½
Lowest	40 5	40 8½	34 0	34 2½	44 8	44 10½
Close	40 6	40 9	33 11	34 1½	44 8	44 10½
Prev. close	40 5½	40 8	33 10	34 0	44 7½	44 10

BARROW-IN-FURNESS, May 29.—Less activity is shown in the hematite market, and full advantage was taken of the holidays, both by makers in the stoppage of works, and by business men who have very few orders to place, and who for the most part confine their purchases to their actual immediate wants. Smelters generally have about three months' orders in hand. Only 33 furnaces are in blast, but two furnaces which have been lying idle for some time at the Cleaton Moor Ironworks, near Whitehaven, are being prepared for relighting. In addition to warrant stocks makers hold large parcels in their own yards. Makers still ask 45s. 6d. for mixed Bessemer numbers net f.o.b. Forge and foundry iron is in small demand. Steel makers are fairly off for orders for heavy rails and tinplate bars, but these are the only two departments at work in the district. Heavy rails are cheaper at £3 10s. to £3 12s. 6d. Iron ore is very quiet at 8s. 6d. net at mines for ordinary qualities. Shipbuilders report a scarcity of orders. Coal and coke quiet at late rates.

Official Gazette.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Adjudication.

JAMES WESTLAKE, Perseverance Works, St. Dunstan's-road, Bowcommon-lane, metal refiner and merchant.

Order made on Application for Discharge.

THOMAS BRYDE BRODBELT, Tattenhall, Cheshire, trading at Liverpool as Sampson, Moore and Co., mechanical engineer, also trading with Alfred Harvey Haydock, as T. W. Brodbelt and Co., at Liverpool as timber merchants and wood sawyers—bankrupt's discharge suspended until a dividend of not less than 10s. in the £ has been paid to the creditors, with liberty at any time after the expiration of two years from the date of the order to apply for a modification thereof, pursuant to Section 8 of the Bankruptcy Act, 1890.

Letters to the Editor.

*** *We do not hold ourselves responsible for opinions expressed by correspondents.*

*** *The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

*** *Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

SCREW-CUTTING LATHES.

To the Editor of THE MECHANICAL WORLD.

SIR,—I should like the opinion of some of your readers who have had considerable experience in screw cutting, as to whether it is possible to cut a true thread, either right or left hand, in any ordinary lathe to be found in a general engineering shop, without having some of the threads thicker than others when cutting square threads. If so, does the fault lie in the lathe or the turner, or the tool, as so many screws are cut with the threads of various thicknesses? I have seen the question asked in several engineering papers, but the answer has been that it is the fault of the tool, which I very much doubt, because I have put a tool in the lathe and run a cut 3 or 4ins. up a piece of iron, so that the tool will just cut a thread deep enough to be seen, and then cut a left-hand thread another 3 or 4ins. long on the same piece of iron, with the same tool and the same wheels on. I have then measured the threads, and found those in the right hand will all measure the same, while those in the left hand will be two or three different thicknesses, all the thick threads and all the thin ones coming at equal distances apart. Any information on this subject would greatly oblige me and a great many other turners, as I believe it is only in badly-constructed lathes that this difficulty is to be met with.

SCREW JACK.

Gloucester, May 22.

THE STUDY OF ELECTRICAL ENGINEERING.

To the Editor of THE MECHANICAL WORLD.

SIR,—I am much impressed with the article on this subject, as so few writers take a liberal view of these questions. It is the fashion to talk about technical education, and at the same time to surround all or most of what is done with so many restrictions and heavy expenses, that it is utterly impossible for lads who have no parents with deep pockets to stand the shadow of a chance. To make the thing popular the prizes should be open to all. The well-to-do class recognise the value of a liberal education, and most of the schemes appear to be framed in their interests. Given equal chances in education, the difference between the poor and well-to-do lad is great. One has to work for his living, the other waits for a genteel situation and gets dubbed a gentleman.

Notice all the schemes of the present time. All the Government prizes in engineering are so expensive that it is impossible for poor lads to reach them.

The Government scheme of education has absorbed most of the charities all over the country and given them to the grammar school—keeping the cream for the well-to-do class and giving the skim-milk to the poor. Evidently the poorer classes had very little to do with the framing of this scheme.

What is wanted, if we really wish to improve the masses and not the few, is to put out the brotherly hand in earnest, by placing the means of advancement within the reach of those we wish to benefit. Grants of money should be made to help the poor forward. It is a glorious thing to see the grand plants that are being laid down for the furtherance of scientific research; but I want to see them put within the reach of all. There should be a good free library, containing the best works, in every town. The classes for training should be much cheaper. The first and second-class prize winners should be treated liberally, and if found worthy their expenses should be fairly met. I do not find so much fault with those who have the means; the question with me is my poorer brethren.

J. KNIGHT.

Louth, May 22.

Miscellaneous Items.

It is proposed to construct an electric railway between the towns of Malmö and Lund, in West Sweden.

A tramway is about to be constructed at Dessau, Germany, the motive power being supplied by gas motors.

The new telegraph line to Kashmir, from Srinagar to Gilgit, is 12,000ft. high at the summit of the Tragbal Pass.

The Somerset and Dorset Joint Railway Company announce that on and after July 1 no second-class carriages will be run on their line, and that second-class fares will be discontinued.

The Belfast Harbour Commissioners have decided to have the Queen's Quay and the Abercorn Basin lighted by electricity, and the operations in connection with the undertaking have been already commenced.

There are more than thirty direct lines of steamers from Europe to the east coast of South and Central America and five to the west. There are only six American lines to the east coast, five of which are owned by English companies, while on the west coast America is unrepresented.

For the first time in its history, the Board of Trade has sanctioned the use of automatic signals on a railway. This concession has been made in the case of the overhead electric railway in Liverpool; and though the line is only seven miles long, the company will save from £2000 to £3000 yearly in signalling expenditure.

The new swing aqueduct at Barton, which was filled with water on the 14th ult., was satisfactorily tested on the 22nd ult., the motive power being supplied by two steam engines. The new aqueduct, now that it is filled with water, weighs about 1700 tons, but notwithstanding this, it required no more than the strength of four men to move it back to its original position.

The first steam lifeboat built for the National Lifeboat Institution was successfully tested on the Mersey on the 22nd ult. She is propelled by engines acting upon pumping machinery which give motion to the vessel by ejecting from four turbines at the vessel's side the water admitted at the bottom of the hull. This, expelled at the rate of a ton per second, propels her at the rate of nine knots.

It is estimated that there are now over 24,450 miles of telegraph wires in operation in Japan. During the past year no less than ninety-three new offices were opened in that country.

A report has just been drawn up by a special committee appointed in America on the considerable difference in yield of locomotive boilers taken in connection with that of the improved boilers in use in factories and works. The experiments showed that in locomotive boilers 50 to 60 per cent. of the total heat of the fuel escaped without having served in the production of steam. The yield was improved 5 per cent. by placing a brick hearth in the furnace, so as to maintain as long as possible the hot gases in contact with the heating surface, which also had the advantage of largely decreasing the production of black smoke.

At the Rock Springs coalmine, Rock Springs, Wyoming, an electric locomotive has been introduced to haul a number of trucks a distance of 6000ft. The current is supplied by a dynamo located a mile distant from the mouth of the mine, the generating pressure being 550 volts. The loss in transmission from the power house to the mine is about 10 per cent., so that the current received at the mine has an electromotive force of about 495 volts. The locomotive, which is of 60H.P., is of 30in. gauge, and it collects the current from an overhead wire, the rails forming the return. It hauls thirty trucks, which, when filled, weigh forty tons.

During the year 1892 the Hydrographic Department received information concerning the discovery of 132 rocks and shoals dangerous to navigation, many of them being small pinnacles rising up from deep water, which are always difficult to detect. Of these, 20 rocks were reported by H.M. surveying vessels, 16 by other of H.M. ships, 9 by various British and foreign vessels, 17 were discovered by vessels striking on them, and 70 were reported by Colonial and foreign Governments. From this, says the hydrographer in his report just issued, it will be seen that the number of dangerous rocks and shoals annually discovered is increasing. In the previous year they amounted to 121, and in 1890 to only 75.

Queries.

☞ **Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.**

☞ **Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.**

WOOD'S AUTOMATIC PRESSURE RELIEF VALVE.—Required the address of the makers of this valve.—BELL AND CO.

OIL MERCHANTS.—Will any reader give me the London address of the Cleveland Lubricating Oil Company, U.S.A.?—A.H.

RAILWAY CROSSINGS.—Given the ratio of angle of intersection, say 1 in 8, what is the simplest method to convert into degrees of the quadrant?—L. V.

JIGS FOR DRILLING.—The Americans often use what is termed a jig for drilling. Will any one kindly give a sketch, together with drill?—DRILLER.

CHURCHILL SLIDE VALVE.—Can any correspondent inform me who are the makers of the "Churchill Patent Slide Vale"? Any information would be thankfully received.—J. M.

GUTTA - PERCHA.—Can anyone tell me of a process for melting either raw or manufactured gutta - percha, and how, after moulding, to cause the gutta to set firm and solid?—J. C. W.

RETEMPERING EDGE TOOLS.—Will any reader inform me if there is any method of tempering pattern makers' chisels and gouges that have been burnt in a pattern-shop?—CYMRO.

CLEANING BOILER TUBES.—Will some reader describe a useful tool to remove hard, thick scale from cross tubes in a vertical boiler? Tubes 9ins. diameter and 4ft. 6ins. long.—NOVICE.

WARSOP AERO STEAM ENGINE.—Any information about the working of the above engine, tried about 1870, such as the effect on the boiler, cylinder, piston rod, etc., will oblige C—M. R.

GALVANISING.—Can any reader inform me whether it is possible to do galvanising on a small scale, say 3 or 4cwt. spelter bath? also the process of preparing cast-iron work for the bath?—T. J.

CASE-HARDENING FURNACE.—Will any practical reader give a sketch of a good furnace for case-hardening purposes, cutter-heating, etc., gas, liquid fuel, or coke, or the name of any maker of such?—LISTER AND CO., Keighley.

KEYS, COTTERS, ETC.—Can anyone inform me what kind of steel is used for making keys and cotter pins as used on most engines? The keys that are bought seem to be of better quality than the so-called mild steel as sold at very little more than the price of fair merchant iron.—STEEL.

STEAM REVERSING GEAR.—I should be much obliged if any reader will explain the working of a steam reversing gear for locomotives, which I have seen on the following railway companies' engines:—Glasgow and South-Western, Mersey Tunnel, and South-Eastern. A sketch would assist me.—F. TURTON.

THEORETICAL DIAGRAMS.—Will any reader sketch and describe the theoretical indicator diagrams which would be obtained from a set of triple-expansion engines, having given—Load on safety valves, 150lb.; height of barometer, 30in.; ratio of cylinder volumes, 1, 2½, 5; total ratio of expansion, 8?—HYPER.

CONDENSING COIL.—In constructing a condensing worm and tank, what amount of coils are necessary so that the distilled water may be quite cold, and what would be the quantity of water in tank to obtain the result? How can I arrive at the final temperature of water originally cold which has passed through 500ft. run of 1½in. pipe, the pipes being immersed in a tank containing water at a temperature of 200° Fah.?—CALOR.

DYNAMO WINDING.—Can any reader oblige me with the proper winding for an E.P.S. type dynamo of the following dimensions (in centimetres), so as to obtain at least 4 volts 3 ampères at a speed of about 2000 revolutions per minute:—Length of magnet bar, 11; length of yoke piece, 8·4; width of magnet and yoke piece, 5·3 each; depth of yoke piece, 2·5; thickness of magnet bar inside bobbin, 3; diameter of armature, 5; length, 5·3; air gap, ½ millimetre all round? It has a laminated armature, with 12 interruptions $\frac{3}{16}$in. wide by ¼in. deep, and a corresponding number of sections in the commutator. The magnets are of Swedish cast iron. I have tried it with 2000 turns of No. 38 B.W.G. on the field and 120 turns of No. 26 B.W.G. on armature, but can get hardly any current.—E. P. S. TYPE.

FEED PUMPS.—In working out feed pumps for common high-pressure engines, Molesworth says, p. 493:—"Take cubic contents of cylinder and one steam passage and multiply by 4, and divide by proper specific volume for given pressure." Why multiply by 4? There are only two cylindersful of steam discharged to one revolution or one stroke of the pump. Then, again, should not the cubic contents of cylinder be taken to cut off only? For instance if steam is cut off, say, at half-stroke, and initial pressure be 100lb., the specific volume for which is 270, we find a great difference from the plan of taking the full cylinder at the average pressure, which at 100lb. initial pressure will be 75 average, the specific volume for 75 being 353, not to mention the difference in the two cubic capacities. Feed pumps worked out according to Molesworth's rule and others always come out much too large—nearly three times. I shall be glad if some reader will explain this.—COLD WATER.

Replies.

☞ **Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.**

☞ **Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.**

W. B.—You will find lead to be the best material.

POLISHER.—How large are the castings you wish to polish?

A NOVICE.—Your governors should run at about 36 revolutions per minute.

STUDENT.—Munroe's "Construction and Management of Steam Boilers" will best meet your requirements.

ANXIOUS.—You cannot raise the water by either method more than 30ft., and we would therefore advise you to fix a pump about 20ft. down the well.

BORING TOOL.—There is no simple way of doing what you require. Apply to the Square-hole Drilling Machine Company, Queen Victoria-street, London.

OLDROYD AND BLAKELY (Grünberg).—Messrs. Oldham and Son and Messrs. Wild and Booth, both of Denton, Lancashire; and Messrs. J. Cheetham and Son and Messrs. J. Hegginbottom, both of Hyde, Lancashire, are makers of the machinery you require.

A. R. WHITE.—You are no doubt qualified to work in a drawing office, but you would have to commence at a merely nominal salary, as you have had no experience. Your best plan is to seek admission to a drawing office of some works in which your practical experience is mostly likely to be of service.

YOUNG ENGINEER.—It is impossible to calculate the position of the centre of gravity of the lever unless you furnish its dimensions. If the taper is not considerable, you may take half the length of the lever as the distance sought, without introducing any serious error. The same remark applies to the tail portion of the lever.

W. W.—Theoretically no weight would balance the ball, because the energy of the falling weight would expend itself in lifting the balance at the other end of the lever. If the balance weight is made very large in comparison with the falling ball, the lever will bend probably; while if it is made strong enough to resist deformation, the blow will virtually be received by the fulcrum of the lever.

DIAGRAM.—No; you should measure from the expansion curve to the back-pressure line, and not from the atmospheric line, as you have done. We fail to understand the use of working up a card in two operations. Many engineers still adopt this method, but it involves much more work and just doubles the inaccuracy due to errors of observation. All that is required, except in special cases, are the lengths of the several ordinates intercepted between the steam and expansion line on the one hand, and the back pressure line on the other. No fault can be found with the card from the top side, but a little more lead would improve that from the bottom.

CLEANING GALLOWAY TUBES.—Can any reader inform me of some acid with which I could remove thick scale from a number of Galloway tubes which are not accessible by scrapers?—BOILER. — *A.* — Messrs. Lee, Howell and Co. Limited, Tipton Engineering Works, Tipton, would like to communicate with you.

METALLURGICAL FURNACE.—Can any reader furnish me with a scheme for supplying the heating power necessary for a metallurgical laboratory situated in iron-ore mining district, and where no gas is available? A small muffle furnace would be required, in addition to the ordinary heating power, and the fuel used is charcoal. Accommodation only required for one chemist.—H. S.——*A.*—Messrs. Nelson and Sons, Station-road, Twickenham, London, make a furnace which will probably suit you.

WIRE ROPE TRANSMISSION.—I want to transmit 60H.P. from a turbine running at 400 revolutions per minute, by a travelling wire rope to a mill main-shaft running at 250 revolutions, distance 100yds., and at 70yds. from turbine, a right-angle bend. There is a slight rising gradient from motor to mill. Will someone kindly tell me size of pulleys to use, diameter or circumference of rope, and speed? Can I drive direct without an intermediate gearing or countershafts? What is the best method of turning the angle, and should one or more ropes be used?—MINER. ——*A.*—Use pulleys 9ft. diameter, rope ⅝in. diameter, and run pulleys at 120 revolutions per minute. Turn the angle with mitre gearing, and have four pulleys and one rope for each drive.—T. R.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.
Where complete specification accompanies application, an asterisk is suffixed.

15th May, 1893.

9657 TUBE and LIKE ROLLING MACHINES. W Pilkington and others.
9658 PACKING SPRINGS for STEAM ENGINES and OTHER MACHINERY. R W Anderson.
9660 NON - CONDUCTING COVERINGS for BOILERS, TUBES, and STOVES. W P Thompson. (*L. Wertheim, Germany.*)
9667 CONTROLLING the MOTIONS of STEAMSHIPS. A W Bibby.
9670 ELECTRO-CHEMICAL PURIFYING PROCESS in IRON MAKING. S D Williams and others.
9671 PNEUMATIC and HYDRAULIC PRESSURE as an AUXILIARY and AUTOMATIC FORCE in DRIVING MILLS, VEHICULAR WHEELS, ETC. C Colwell.
9676 AUTOMATIC SAW-SHARPENING MACHINE. R H and J F Shaw.
9678 SHIP'S ANCHOR. J B Noble.
9688 GUNPOWDER CARTRIDGES for MINING and BLASTING. J McNab and J Dickson.
9691 FILTERING SEWAGE. C Waite.
9699 CONNECTING-JOINTS for ELECTRIC MAINS, TELEGRAPH WIRES, and TELEPHONES. W Gordon.
9700 NAVIGABLE VESSELS. H V KEESON.
9703 TURNING RAILWAY POINTS and OPENING and LOCKING RAILWAY SWITCHES.* G Brockelbank.
9706 VEHICLE WHEELS. W J Mair.
9709 MULTI-UNIT NUMBERING WHEELS and RATCHETS. J S Ashley.
9726 STEAM TRAP. H Walton.
9728 SMELTING FURNACES. M A E Thivet-Hauctin.
9730 COUPLING APPARATUS for RAILWAY CARRIAGES. L Berden.

16th May, 1893.

9743 TUBULOUS STEAM BOILERS. W H Wilson.
9749 PREVENTING the POLLUTION or FOULING of the ATMOSPHERE in RAILWAY TUNNELS. C Anderson.
9750 AIR PROPELLERS or VENTILATING FANS. S Standring and W Howgate.
9751 AUTOMATIC INDICATOR. C E Stephenson.
9753 ELECTRICAL and OTHER MEASURING INSTRUMENTS. W E Ayrton and T Mather.
9760 CLIPS. T W Sheffield.
9762 AMALGAMATING MACHINE. W A Green.
9763 COMBINED AMALGAMATING and CONCENTRATING MACHINE. W A Green.
9769 ADDING-MACHINES.* B H Phillips.
9771 APPARATUS for SUPPLYING GAS or OTHER FLUID on PREPAYMENT. J Hawkyard and J Braddock.
9775 FLYING MACHINES. H Middleton.
9777 COUPLINGS for RAILWAY VEHICLES. E Friesicke.
9778 ORE PULVERISER and GOLD SAVER and MINERAL CONCENTRATOR. B J Atterbury.
9779 CIRCUIT SWITCH.* C A Allison. (*The Electrical Specialty Company, United States.*)
9780 ELECTRICAL APPARATUS for OBTAINING LIGHT.* F V Wood.
9785 VALVES. W Buckwell.
9787 GAS PRESSURE REGULATORS. A G Brookes. (*D Wilson, United States.*)
9800 MINE BLASTING or RENDING.* R Haddan. (*A Kuehne, United States.*)
9805 CONTACTS for MAKING and BREAKING ELECTRICAL CIRCUITS. Siemens Bros. and Co. Limited, and F Jacob.
9809 PUMPS.* R O Graham and F C Smith.
9810 INCANDESCENT ELECTRIC LAMPS. H C Bull.
9814 MEANS for AUTOMATICALLY EXTINGUISHING a MINER'S LAMP. W Barns, jun., and C O Hillsdon.
9815 MACHINES for FORMING WOODEN TUBES.* M E Brigham.
9817 TREATMENT of COMPLEX SULPHIDE ORES.* W R Ingalls and F Wyatt.
9818 UNDERGROUND CONDUITS for ELECTRICAL CONDUCTORS.* J F Cummings.
9819 ELECTRIC CIRCUIT CONTROLLING DEVICES.* W P Hall.
9821 GALVANOMETERS.* H H Lake. (*Whitney Electrical Instrument Company, United States.*)
9822 APPARATUS for STARTING GAS ENGINES. H T Crewe.
9824 WRENCHES. F B Wells.

17th May, 1893.

9834 TILT HAMMERS. J W Kilner.
9842 PEDOMETER. G C Thomas and J Parfitt.
9845 APPARATUS for the PREVENTION of SMOKE. J Scholefield and S Barker.
9853 LOCK NUT for SCREWED BOLTS. W Gollin.
9855 BELT SHIPPERS. W Taylor.
9864 ELECTRICAL SWITCHES. R G Evered and A Watson.
9867 SURFACE CONDENSER. P Rebbechi.
9868 APPARATUS for SCARFING LAP-WELDED TUBES. J Eccles, jun.
9869 FURNACES and BOILERS of LOCOMOTIVES. D Morgan.
9871 APPARATUS for DREDGING by MEANS of PUMPS. J McGregor.
9891 METHOD of GAINING POWER. F Sternberg.
9900 APPARATUS for HEATING and CIRCULATING WATER for WARMING RAILWAY TRAINS and BUILDINGS. M M Brophy, of the firm of J Slater and Co.
9908 NEW MECHANICAL MOVEMENT. R de R Layton.
9906 ELECTRODES for VOLTAIC BATTERIES and ELECTROLYTIC DECOMPOSITION CELLS. D G FitzGerald.
9913 CYLINDRICAL CASKS or DRUMS. R E M Lagerwall.

18th May, 1893.

9919 PROCESS of CASTING INGOTS and CHILLED METAL ARTICLES. G Nelson and A Turner.
9932 METHOD of MAKING the PEACOCK PATENT GRIP-NUT BLANKS from PATENT SLIT STEEL. J Holding.
9935 COMPOUND STEAM ENGINES. H Wood and N Macbeth.
9951 MECHANICAL DEVICE for REGULATING the SUPPLY of WATER to WATER WHEELS or MOTORS. W A Turner and others.
9952 FILTERING MACHINE. H C Atkins.
9955 APPARATUS for the CONCENTRATION of MINERALS. H F Julian.
9956 PROCESSES for the TREATMENT of MINERALS for FACILITATING the EXTRACTION and RECOVERY of METALS CONTAINED THEREIN. H F Julian.
9957 APPLIANCES for USE in the FIRING of SHOTS for BLASTING COAL. J McCoy and A Dean.
9960 CORRUGATED or CHANNELED FLOORING for BRIDGES, ETC. J Shewell.
9964 MACHINERY for PRESSING SOLID or PLASTIC SUBSTANCES. W Wilkinson.
9965 WORKING and WELDING of METALS by ELECTRICITY.* A Longsdon. (*The firm of F Krupp, Germany.*)
9967 VALVE for CONTROLLING VARIABLE POWER for CRANES and HOISTS.* C Cornes.
9971 VALVES. G A Farini.
9983 BILGE-PUMP. P J C Delegrange.
9985 MACHINES for TURNING BUTTONS.* G F Redfern. (*D B Shantz, Canada.*)
9987 AERIAL SHIPS. W van de Voorde and C Bugkel.
9997 GENERATING ELECTRICITY DIRECT FROM HEAT S Coxeter and H Nehmer.

19th May, 1893.

10,009 SMOKE PREVENTION and the BETTER COMBUSTION of FUEL.* O Howl.
10,012 RELIEF-VALVES.* H B and J S Watson.
10,014 APPARATUS for the MEASUREMENTS of LIQUIDS. O Elphick.
10,015 APPARATUS for USE in the UTILISATION of ELECTRICAL ENERGY for CULINARY PURPOSES. R E B Crompton and H J Dowsing.
10,017 FURNACES for STEAM BOILERS.* L S Dulac.
10,022 PREVENTING INCRUSTATION in STEAM BOILERS.* J Pitlik.
10,024 ROLLING WIRE RODS. W Williams.
10,029 STEAM ENGINES. W George.
10,047 FACILITATING the ATTACHMENT of COCKS, TAPS, or VALVES to CASKS and TANKS. T L Banks.
10,054 COLLIERY and OTHER SAFETY LAMPS. A James and others.
10,056 COMMUTATORS for ELECTRIC MACHINES. C Olivetti.
10,060 TENSION DEVICE for SAWS.* L Chevenier.

20th May, 1893.

10,081 ELECTRO-MOTORS. W Greenhalgh.
10,096 METALLIC OXIDES and COMPOUNDS. E de Pass. (*H Thofehrn, France.*)
10,100 ROLLERS and PULLEYS for COLLIERY and OTHER PURPOSES. S Shepherd.
10,102 APPARATUS for SIGNALLING by MEANS of an OXYETHER GENERATOR JET and LAMP. J G Parvin.
10,105 WINDLASS. C R Eddy and S E Whitehead.
10,107 TELEPHONE CALL. J H Kinsman.
10,116 SPRING MOTOR ENGINES. P Piesker and S Mark.
10,119 SINGLE ACTING COMPOUND TANDEM ENGINES. J C Peache.
10,125 MOVABLE JOINTS for TUBES. J Dunkel.
10,128 APPARATUS for COMPRESSING and SHAPING. H Edmunds.
10,129 ELECTRICAL CONDUCTOR. H Edmunds.
10,134 ARMATURES for DYNAMO-ELECTRIC MACHINES. W B Sayers and others.
10,136 METALLIC JOINTS for BOILERS and OTHER APPARATUS.* J and A Niclausse.
10,139 DEVICES for CONVERTING RECIPROCATING into ROTARY MOTION.* F Jackson and others.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to SIR H. READER LACK, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

***** Where the numeral is absent, the Advertisement does not appear this week.**

The Mechanical World

EVERY FRIDAY. ONE PENNY.

All who are practically engaged in Mechanical Engineering or Scientific Industries are invited to avail themselves of THE MECHANICAL WORLD columns for information. We are glad to help the diffident, and, so far as we can, remove the obstacles which frequently prevent practical men from communicating their ideas.

We wish it to be distinctly understood that we cannot, for any consideration, and will not knowingly, allow our editorial columns to become the vehicle for mere advertisements of machinery, apparatus, or anything that falls within our province to notice.

Every correspondent should forward his name and address, not necessarily for publication unless so desired. We do not undertake to return MSS. unless specially requested, and in such cases stamps should always be sent.

All communications relating to editorial matters should be addressed to the Editor of THE MECHANICAL WORLD, at the Manchester, and not the London, Offices.

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☞ Owing to the large demand for back numbers of THE MECHANICAL WORLD, we are compelled to fix the following scale of prices:—Copies published in 1887, 6d. each; 1888, 5d.; 1889, 4d.; 1890, 3d.; 1891 and first half of 1892, 2d. each.

All remittances payable to EMMOTT AND COMPANY LIMITED, Publishers, either at New Bridge Street, Manchester, or 85, Strand, London, W.C.

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The actual sale of "The Mechanical World and Metal Trades Journal" is now greater than that of all the other recognised Engineering Journals put together.

FRIDAY, JUNE 9TH, 1893.

Condenser Tubes.

ATTENTION has lately been directed to a source of weakness in the condensers of marine engines, by Engineer Hunt, in his report on the failure of the U.S. battleship "Baltimore." He points out that when through accident or wear the tin coating has been removed at any point, a brass surface is left exposed, adjacent to and intimately connected with a tin (tin-lead alloy) surface, and this is covered by an exciting liquid—namely, sea water. That under such circumstances galvanic action should take place cannot be wondered at, and one element or other of the local battery thus formed would undoubtedly be attacked. To prove the existence of a current in a couple similar to this, Engineer Hunt immersed two sections of condenser tubing, from one of which the tin coating had been removed, in salt water, and found a very perceptible current, using a galvanometer that was not at all sensitive. Zinc, a constituent of brass, is the most electro-positive of all the common metals, and would in such a couple be the metal destroyed, and that it was destroyed was shown by an analysis of the altered tubing. The most remarkable result of the investigation was the observation that the spongy copper left after the zinc had been destroyed by the galvanic action, absorbed nearly three per cent. of water by weight, and nearly 25 per cent. by volume, showing that the alloy used for the tubes (Cu 60, Zn 39, Pb 0·25) was not a suitable one.

Telephony v. Electric Traction.

A VERY important question, affecting a large and growing industry, will shortly be taken into consideration by a Parliamentary Committee. We refer to the conflicting interests as between the electric-light and power industry and the telephone service. During the past four years the National Telephone Company, which virtually has a monopoly of the telephone service in the United Kingdom, has opposed in Parliament some fifty bills relating to electric-light and power undertakings, and has succeeded in forty cases in getting clauses inserted in the bills giving protection to the Company's telephone system. In the remaining ten instances, where the promoters of the bills combated the opposition of the telephone company, the results were by no means uniformly favourable to the telephone company. The substance of the protective clauses may be briefly stated as follows:—The electric circuits and works shall be so constructed and the tramways worked in such a manner as to prevent any injurious interference by induction or otherwise with the electric circuits used or intended to be used by the telephone company, or with the currents in such circuits. Now, the telephone company does not use metallic circuits, but single wires with "earth" return. If it had adopted a twin-wire system it is possible that no attempt would have been made to get such an obnoxious clause inserted. However, as electric traction on tramways, and especially in the case of the overhead trolley system, cannot very well be governed by electric-light regulations, the insertion in electric-traction bills of clauses protecting the telephone system—which ought to protect itself by using metallic circuits, as other countries do—tends greatly to retard the development of cheap electric traction. It is therefore not surprising that those who are concerned in the progress of electricity as a motive power have formed an Electrical Traction Association to protect this branch of industry. Quite recently representatives of this association and of the telephone company were received at the Board of Trade to consider the opposing interests. Sir Courtenay Boyle, after hearing both sides, intimated that the fact of having hitherto granted protective clauses did not imply the establishment of a uniform principle that there should be such clauses in favour of the telephone company; that since 1889 a great deal of knowledge had been gained; that the Board of Trade would communicate with Parliament to see whether the matter could be considered and settled, and that in the meantime no protective clauses would be inserted in favour of the telephone company. The result of this is the appointment of a Joint Committee of the Houses of Lords and Commons: "To consider and report whether the grant of statutory powers to use electricity ought to be qualified by any prohibition or restriction as to earth-return circuits, or by any provisions as to leakage induction or similar matters, and, if so, in what cases and under what conditions. And if the Joint Committee are of opinion that any such prohibition, restriction, or provision should be enforced, to settle the necessary clauses." Thus it will be noticed that the question to be considered is, in effect, whether the telephone system is to be protected or not. The Joint Committee will doubtless sit for several days, and will receive a large amount of evidence from traction, telephone, and other interests. In addition to the London County Council, the Association of Municipal Corporations (a body composed of representatives of the local authorities throughout the country) has moved in the matter. This is not surprising when it is remembered that out of the 946 miles of tramways existing in the United Kingdom, no less than 261 miles of lines belong to local authorities. The Association of Municipal Corporations has held two meetings to consider the subject, the last having taken place on the 1st inst.; but beyond the fact that a committee has been appointed to deal with the question generally and at the meeting of the Joint Parliamentary Committee, nothing is known as to which position or side the association will take up. It is, however, significant that not only were the proceedings kept secret, but also that Sir Albert Rollitt, the president of the association, and who occupied the chair at the two meetings, has recently become a director of the telephone company. Still, the members of the electrical industry are not idle, as was shown at an assembly on the 2nd inst. of the Electrical Section of the London Chamber of Commerce—a section of which the members are representatives of manufacturers and light companies, etc. On that occasion an Electric Traction Sub-committee of the Electrical Section was formed, and the already-mentioned Electrical Traction Association was merged into it so as to have combined action. This sub-committee is constituted with power to raise funds, engage counsel, and take such other steps as might be necessary for the advocacy of the protection of traction interests. The committee is powerful, and has power to add to its number. This, then, is the present position of affairs; and there is no doubt, when the Joint Parliamentary Committee meets, that one of the most fierce struggles in the electrical industry of the United Kingdom will commence. On the face of it, it seems that the result of the inquiry will be in favour of the traction interests; but the strong position of the telephone company renders it necessary that all possible support should be given to the Electric Traction Sub-committee before the Joint Parliamentary Committee.

Mining Engineers.

THE Federated Institution of Mining Engineers held a general meeting at the Institution of Civil Engineers, on Thursday and Friday last week, Mr. George Lewis, the president, occupying the chair. In the course of his address, the president observed that the education of the mining engineer of the future must of necessity be of greater importance than in the past, when the mines were worked only from the outcrop or shallow pits. In the near future, the whole, or pretty nearly so, of the collieries working coal on the outcrops would be exhausted, and their places could only be filled by sinking to greater depths and under very different circumstances. He advocated a change in the manner of holding examinations for colliery managers' certificates in so far that, instead of mining engineers examining candidates upon all subjects, professors of the various subjects of mechanical engineering, chemistry, electricity, and mining engineering, should be appointed to undertake the examinations. At the conclusion of the address, various papers were read and discussed, and visits paid to electric-light stations and gas and engineering works.

English Corridor Trains.

THERE is now every appearance of some effort being made to provide reasonable dining accommodation for railway passengers on the long-distance trains of our principal lines, for in the course of the next few weeks the London and North-Western, the Midland, and the Great Northern Railway Companies will place in regular service trains composed of first and third-class carriages, connected by passages from one end of the train to the other, and furnished midway with kitchens and dining-saloons. The train which, from the beginning of next month, will leave Euston Station at 2 p.m. daily for Scotland, will be composed of three sections, the first comprising six coaches for Glasgow, then two for Edinburgh, and next two for the North of Scotland—ten in all. In the Glasgow section will be placed the three dining-saloons, the centre one being known as the kitchen car, and including, besides every convenience for cooking, a butler's pantry, with closets for the stowage of crockery and table furniture. From this car will be served meals to the first-class dining car in the rear of the kitchen car and to the third-class dining car in front of the same. The passages through the dining cars run along the centre, the chairs and tables being placed along each side. Having finished their meal, diners will pass through the balcony gangway connection at the end of the dining-saloon, and reach their ordinary carriages by means of a side corridor, into which the doors of the compartments are made to open. The first-class ordinary carriages are immediately connected with the dining car of the corresponding class, the same order being observed in the case of the third-class dining car and ordinary carriages on the other side of the kitchen car. The occupants of the other sections of the train—for Edinburgh and the North of Scotland respectively—will, of course, have access to the dining cars, the corridor communication being continuous throughout. We cannot doubt the success of the innovation, for the need for some arrangement of the kind has long been acutely felt.

Patents and Inventors.

THE tenth report of the Comptroller-General of Patents, Designs, and Trade Marks, issued to Members of Parliament at the end of last week, affords food for a little reflection at the present moment. As compared with the methods adopted in Germany and the United States, the English system of granting patents for inventions, and so-called inventions, is much inferior; but, at the same time, the patent laws of the two former countries cannot be regarded as perfect. There has been a considerable increase in the number of applications for patents since the new Patent Act came into operation in 1884. As regards the number of applications during the last year (1883) under the old Act, there were 5993 applications; in the following year—that is, the first under the new Act—the number increased to 17,110; in 1885 they receded to 16,101; in 1886 the number increased to 17,176; in 1887 to 18,051; in 1888 to 19,103; in 1889 to 21,008; in 1890 to 21,307; in 1891 to 22,888; and in 1892 the number advanced to 24,171. However, the proportion of applications which obtain patents is gradually diminishing; but, notwithstanding this, the total number of patents issued annually has considerably increased since 1885. The receipts for 1892 from patent fees were £180,566, which, added to the amounts received as fees for designs, trade marks, and from the sale of publications, brings the total up to £199,857. The expenditure was £96,822, so that the surplus is £103,035. There is every reason to assume that the greatest defect of the English Patent Office is the fact that no examination is made as to the novelty or otherwise of the invention or so-called invention; if a provisional specification appears to read correctly, what does it matter to the Patent Office whether the machine, apparatus or arrangement is new? Very little. But it ought to, and a large portion of the annual surplus should be devoted to an examination as to the novelty or otherwise of the patent applied for. As a result of the present system of granting protection, some, and probably many, patents are issued for inventions which have been patented years ago by different individuals. We are not speaking without reason. Many inventors are poor, or comparatively poor, and it is not just that they should be granted protection for ideas that have been patented many times previously, and which protection is of no value; but of this and of the relations between inventors and patent agents we may have something to say on a future occasion.

THE American Board of Ordnance, which has been for some time investigating the newest designs of small arms, has decided in favour of the Krag Jorgensen rifle for use in the United States Army.

Pump Valves.

(Concluded from page 203.)

NEXT amongst disc valves that of Fig. 10 may be noticed. This is a vulcanite-mounted valve, double guided, and constructed as shown. It is enclosed in a cast-iron cage in this case; but where it is guided—as this one is—both at the top and bottom, the cage is not required as a guide, and could be dispensed with. This particular one is 20in. in diameter, and is used

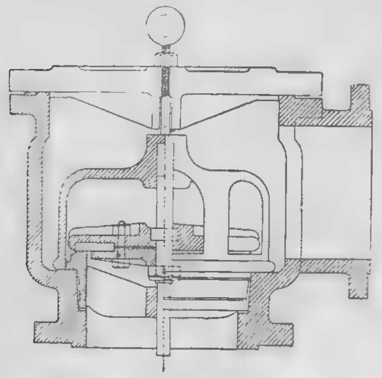


FIG. 10.
(Scale ½in.=1ft.)

in a 90-fathom vertical column, and generally makes 10,000,000 beats before it requires to be changed. The secret of the vulcanite valves is to get the vulcanite good, and encase it into its place, whether

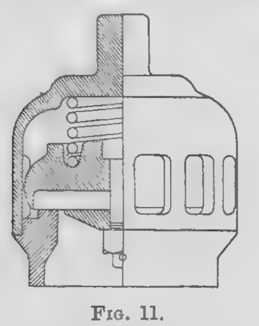


FIG. 11.
Scale 1in.=1ft.)

it be on the seat or on the lid. If the vulcanite is inferior, or if not encased, it will probably splinter off after short service. A valve like this which is not supported in the centre, must be made of crucible steel or malleable iron.

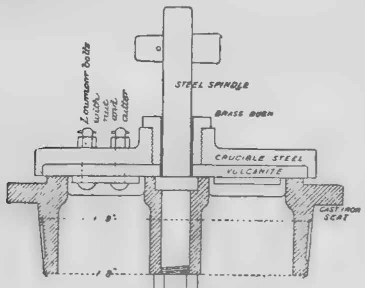


FIG. 12.

Fig. 11 is a sketch of a vulcanite valve from which the general idea of Fig. 10 was taken. This Fig. 11 valve has been used, I understand, as a hydraulic valve up to 800lb. per square inch, and proved itself to be an efficient valve at that pressure.

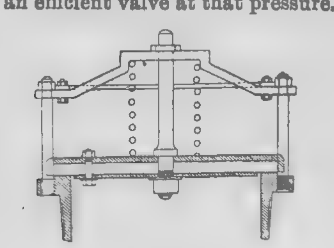


FIG. 13.
(Scale ⅜in.=1ft.)

Fig. 12 is another vulcanite valve, guided in a very efficient way. The special feature of this style is the ease with which it

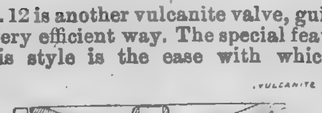


FIG. 14.—12IN. HOLMAN'S VALVE AND SEAT.
(One-eighth size.)

can be changed. It is supported in the centre, and does not require to be so heavy, as it has not the same tendency to break from top weight. I know of a valve of this style which has already done 15,000,000 beats and is still working all right; but the head is only 30 fathoms.

Fig. 13 is still another of these vulcanite valves, but differs in its style. It is guided at the circumference and at the top centre, and has the addition of a steel spiral spring. The plate in this case is of forged steel. A valve of this style is at present working at one of the pits of the Fife Coal Company, and works well.

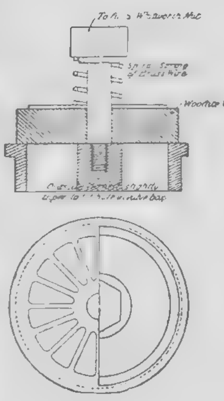


FIG. 15.
(Quarter size.)

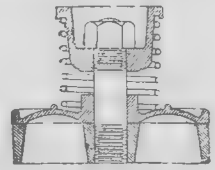


FIG. 16.—WATER VALVE, SEAT, AND GUARD.
(Quarter size.)

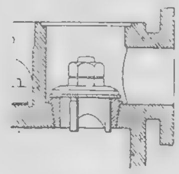


FIG. 17.
(Scale ⅜in.=1ft.)

Fig. 14 is a vulcanite valve where the vulcanite is not encased; and my experience of it was that a good supply of new vulcanites required to be kept in stock to be ready for renewal. This valve seldom lasts long enough to make three-fourths of a million strokes; it is also not a good one for gritty water, as it works on a brass spindle, which soon gets worn and passes a very large amount of water before it is very old.

It is much used by some makers of underground direct-acting steam pumps. Most makers of this class of pump have up to the present time been unfortunate in their choice of valves for mining pumps.

Fig. 15 illustrates a valve adopted in the last-mentioned style of steam pump, which is a step in the right direction. The lid is composed of a recently-invented material called woodite, which partakes of the nature of vulcanised indiarubber. I have not had it long enough at work to speak definitely about it, but it promises very well, and does not cut so readily as rubber. But the head of water it works against is only 20 fathoms in this case.

Fig. 16 is of the same class of valves. It is largely used in Worthington pumps, and makes an excellent valve for clean water, but should not be used as a pit water valve.

Figs. 17 and 18 are leather-mounted valves adopted by the Worthington Company where gritty water is to be pumped at heavy pressures, and they appear to be good valves for that purpose, Fig. 18 especially so.

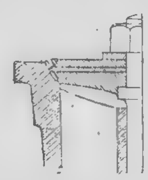


FIG. 18.—THE WORTHINGTON LEATHER CLOSING VALVE.
(Scale ⅜in.=1ft.)

Fig. 18A, a by-pass, is a vulcanite valve used in Moore's hydraulic as regulating valve, and wears well with 1200lb. pressure. I have compared them with brass-to-brass unmounted valves, and the vulcanite far outstrips the brass.

We will now refer to the next form of valves, called double-beat valves. They are really two valves joined together, and the advantage of them is that a little over one-half of the lift gives the same water way, so that, there being less lift, the valve shuts itself with less concussion, and enables a greater number of strokes to be performed with the same amount of shock as in the case of a single-beat valve.

Figs. 19, 20, and 20A are samples of this style of valve suitable for very clean water, and Fig. 21 is a good style for dirty water, because it is packed with gutta-percha or leather where shown. But this valve, if in constant use and getting a large amount of work to do, does not last more than a few months at a time without requiring repacking, as the gutta-percha or leather gets worn down flush, and so begins to leak. I have tried this style of valve, and its life averages 1,000,000 beats. I have known a 20A valve to be hung up, and then to come down suddenly, bursting a pipe, this occurring on two occasions, the valves being then discarded. They are good for about 1,000,000 beats. There being two faces to keep right, there is thus a double chance of failure. There is no doubt, however, that for fast driving this valve is a good one. The arrangement shown at the top of the valve is one with rubber rings and iron washers alternately, to act as a cushion to keep down clatter and regulate the lift. But wherever possible to be applied, a spring is better, as it gives the valve a greater

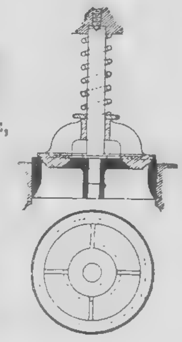


FIG. 19.
ANNULAR VALVE.
(Scale ⅜in.=1ft.)

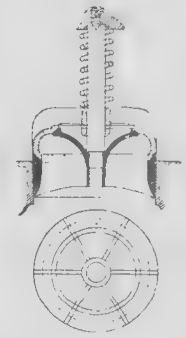


FIG. 20.
(Scale ⅜in.=1ft.)

tendency to keep shut. It opens wide when wanted, and prevents in the valve the tendency known as floating. Springs, if badly used, are apt to break or lose their elasticity, for which reason they are badly spoken of.

A very good style of spring is shown in Fig. 22. It is only in certain cases that

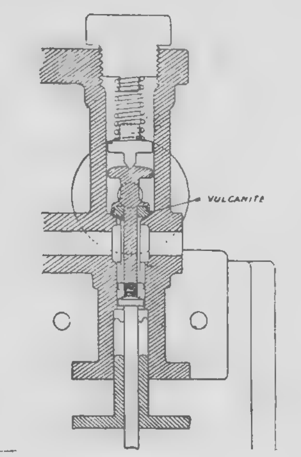


FIG. 18A.

this can be adopted, but the arrangement is a good one. The motion of the valve can be observed and manipulated to perfection.

The idea of double-beat valves may be carried still further. In Fig. 23 is shown a quadruple-beat valve for clean water. This valve has not come under my own observation, but it is in use at the London waterworks, where the speed of the plunger is 200ft. per minute, being double the

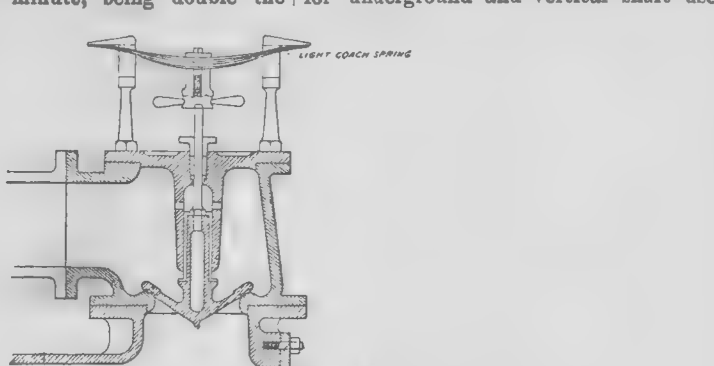


FIG. 22.

speed at which ordinary mine pumps with single-beat valves should be run.

If, by adopting a valve of this description, the safe speed can be so much increased, the subject is well worth consideration. I do not know the head of water in this case. That makes a difference. High speeds are very much safer when the head is low.

Another mode of getting fast driving with little shock is to employ a number of small valves, all independent of each other, fixed to a common plate in the valve chest. This has been adopted very successfully in the Worthington pump, which has gained for itself a name for being a noiseless pump at high speeds. The objection raised to this style of valve arrangement is that when there are so many valves some of them are always sure to go wrong. So far as applied to mining, this style has

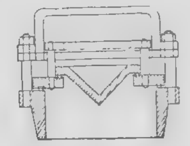


FIG. 20A.
(Scale ⅜in.=1ft.)

not been a success—not because the idea is wrong, but because the wrong kind of valves has been adopted.

In considering the efficiency of a valve, there are three questions on the subject that require to be treated:—

1. What amount of cover should a valve have?
2. At what speed should the water go through the valve?
3. What lift should a valve have?

The amount of cover a valve should have is determined by the style of construction, and varies from 20 to 40 per cent. of the total area of the shell—that is, if the statical pressure of the valve is 100lb. per square inch, it will take a pressure of from 120lb.

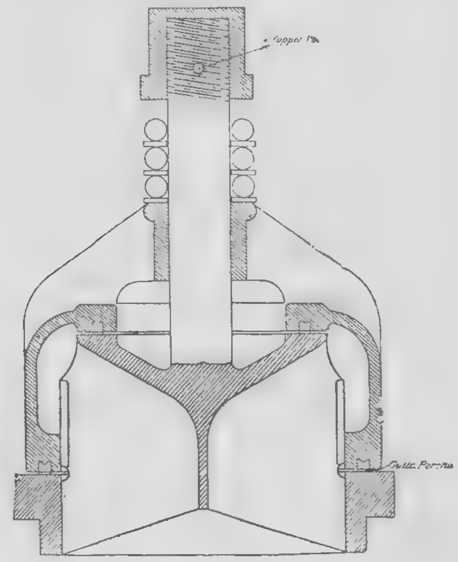


FIG. 21.
(Quarter size.)

to 140lb. per square inch to lift the valve. In a valve such as Fig. 9, and all valves where the bearing surface is of brass or iron, the cover may be small; but in valves such as Fig. 2A, and all valves where the total burden is borne by a soft material, it is necessary to make a broad surface to get durability. The narrow bearing in Fig. 20A and Fig. 21 is the cause of their short life. In direct-working steam pumps, both for underground and vertical shaft use, large cover gives a tendency to jerking at the commencement of the stroke, and should be avoided. A valve should be chosen having not more than 30 per cent. of cover. Where the pump rods in a vertical shaft are unbalanced, in many cases extra weight will be required to lift the valves. This would be a clear case against the economy of the engine.

Regarding the speed at which water should flow through a valve, that is found if we ascertain the speed of the ram, the area of the valve seat in relation to the ram, and the amount of lift the valve gets, so that the answer to this question will be found thus. The speed of the ram, as a general rule, should never exceed 100ft. per minute. The valve area should never be less than 66 per cent. of the ram area, and the lift of a vertical single-beat valve should be one-eighth of its diameter. The velocity of the water through the valve will then be about 30ft. per minute. I have known the velocity of a ram to be as great as 168ft. per minute, and the valve area 50 per cent. of ram area. That, with one-eighth of diameter

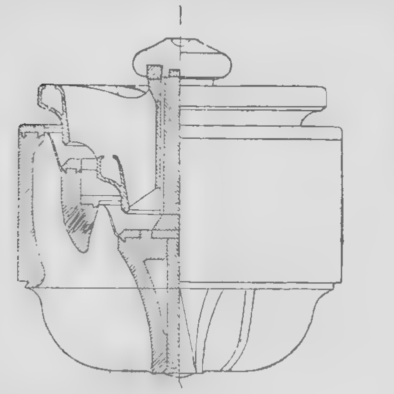


Fig. 23.—Pump Suction and Delivery Valve.
(Scale ¾in. = 1ft.)

4 Beat Valve 27½ dia. for a piston pump the suction and delivery valves are of the same pattern. This valve is suitable for a 20in. pump at 200ft. per min. plunger speed.

The Suction Valves are only loaded with ead.

lift, would give the velocity of the water at 672ft. per minute, which is much too fast. Some makers of underground direct-acting steam pumps give the limit of velocity through the valves, and even through the pipes, at 600ft., but this, in my opinion, is at least twice too fast. It takes one-fourth of the diameter to give full area of a single-beat valve. One-half of this is sufficient as a rule, as already stated. In double-beat valves, one-twelfth of the diameter is sufficient. A very good way to cause a valve to open only the amount that is actually required, and to dispense with spiral springs which are liable to break or lose their elasticity, is to fill up the whole lifting space above the valve with rubber, and let the valve make "lift" by compressing the rubber. I recently had this successfully tried, and it cured a nasty shock, which the spiral spring did not. In this case, however, the valve area was only one-third of the ram area, which is far too small, and does not give the valves a chance to work properly. I am of opinion that there are more chances of shocks with having too large a lift of valve than with having the lift too small.

Many of these remarks are of a general character. To go into detail on every style of valve would entail too much time, but I hope that in the discussion many details will be gone into, especially of valves suitable for pit water.

To make a paper on this subject anything like complete requires the experience of many men put together. Should this paper lead to others of a similar character being brought before the Institute, a good, useful purpose will have been served.

Sugar-making Machinery.

XXXII.

With respect to the proportions of the different parts of spur wheels, those obtaining in ordinary practice may be followed, only adding a little extra material owing

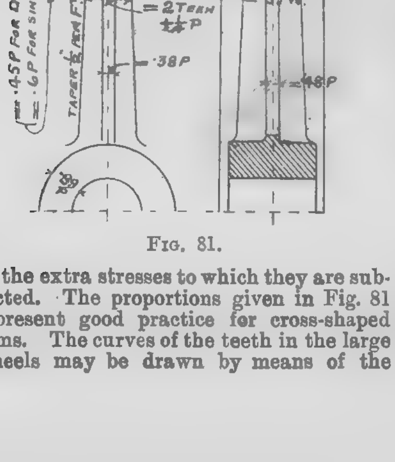


Fig. 81.

to the extra stresses to which they are subjected. The proportions given in Fig. 81 represent good practice for cross-shaped arms. The curves of the teeth in the large wheels may be drawn by means of the odontograph, and then corrected by striking them out with templet full size, to ensure accurate and easy-rolling teeth.

Fig. 82 gives proportions of rim, arms, etc., for wheels with H-section arms. The shapes of the arms for spur wheels are very various. These should be designed primarily to give the greatest strength for the least material; and, secondarily, to obtain simplicity in pattern making and moulding.

Fig. 83 shows the ordinary cross-arm section used in wheels of small size, the general proportions for which are given in Fig. 81.

Fig. 84 is a modification of the latter, which consists in filling up the corners so as to form an inner heart of circular form.

Fig. 85 shows an H-section arm which is largely used with wheel-moulded wheels,

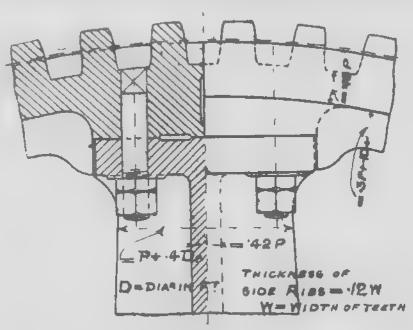


Fig. 82.

being simple in form, easy to cast, and strong. The general proportions for such arms are given in Fig. 82.

Fig. 86 shows an arm of hollow rectangular section, with side facings to relieve the appearance of heaviness. Some makers employ this form of arm for their built-up wheels, or modifications of it.

Fig. 87 shows a simple pipe arm, which is much used for large and heavy built-up wheels. It is a very strong section and easy to make, and offers facilities for machining, etc., if used with built-up wheels.

Fig. 83.

Fig. 84.

Fig. 88 is a pipe arm, with ribs, to give additional strength in wheels of the very heaviest make.

In calculating the strength of the arms for wheels of the built-up form, it is first necessary to ascertain the bending moment

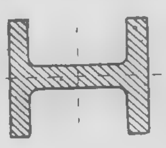


Fig. 85.

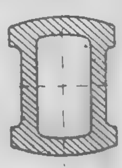


Fig. 86.

on each arm at the boss. This is found near enough, approximately, by dividing the stress on the rim by the number of arms in the wheel, multiplied by the length of arm in feet from pitch line to outside of boss. From this can be calculated by the ordinary rules the requisite metal necessary for any particular section of arm adopted.

Wheels above 8ft. in diameter are usually made in halves, and above 10ft.

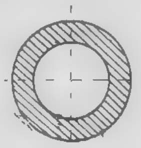


Fig. 87.

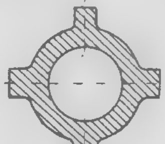


Fig. 88.

in diameter in segments corresponding to the number of arms. The number of arms for spur wheels varies with the ideas of the different makers. The following may be taken to represent ordinary practice:—From 2ft. diameter to 3ft. 6in., 4 arms; above 3ft. 6in. and under 5ft., 5 arms; above 5ft. and under 8ft., 6 arms; above 8ft. to 16ft., 8 arms; above 16ft. to 24ft., 10 arms.

(*To be continued.*)

The little Grecian port of Syra still builds a few wooden ships. Last year it constructed 33 vessels, but the tonnage was only 6373—more than half being under 100 tons each. The industry is decaying—the vessels built being little more than half the number of those built at the same port two years ago.

Machine Construction.

The Construction of Machine Elements.

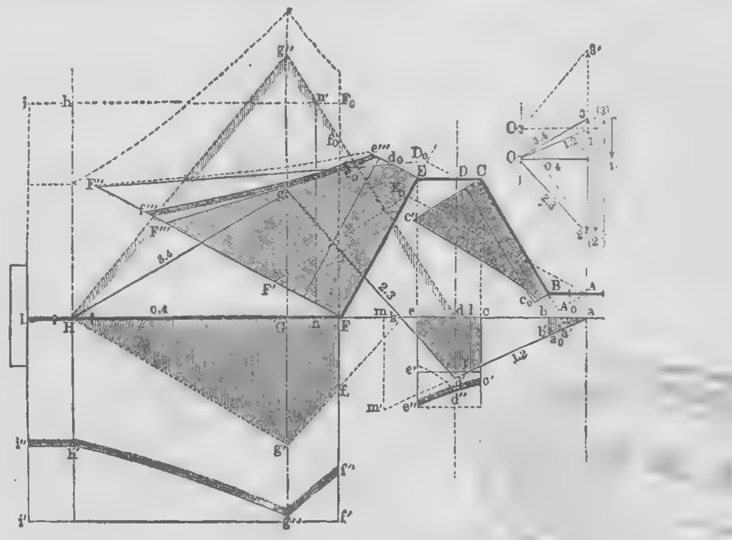
(*Continued from page* 192.)

§ 170.

GRAPHOSTATIC CALCULATION OF THE RETURN CRANK.

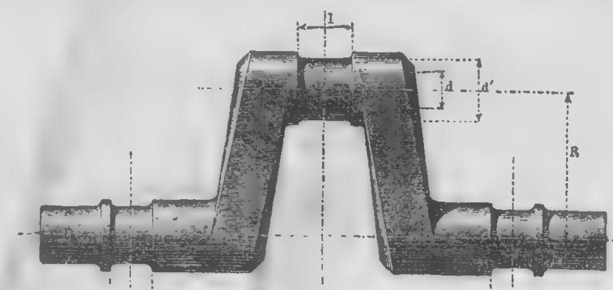
The graphostatic diagram for a return crank, with both main and return crank inclined to the axis of the crankshaft, is shown in Fig. 468. The skeleton A B C D E F G H I is first drawn, the dimensions A B C E and F G being taken to correspond with those chosen to meet the requirements of the cranks under consideration. The pressure 1 upon the return crankpin is here taken as opposed to the pressure 2 upon the main crankpin.

Force Polygon.—After choosing a scale for the measurement of the forces, the force polygon (on the right) can be drawn. The line 0 to 1, measured upward, represents the pressure on the return crankpin; O is the pole chosen on a horizontal line drawn through 0, and the line 1 to 2 represents the pressure on the main crankpin, measured downward. Draw the rays 0 O, 1 O, 2 O, also draw the line $a\,d'$ parallel to 1 O, until it intersects at d' the line dropped from D (the line of direction of the force 2); draw $d'\,g$ parallel to 2 O until it intersects a perpendicular through G, the line of the force 3, which we know acts upward, but the magnitude of which is yet undetermined. In order to determine it, as well as the fourth force which acts at H, join g with H, giving H a as the closing line, which is horizontal because we have chosen the pole O on a horizontal through 0. Now draw in the force polygon O 3 parallel to H g, then the line 2 to 3 is the third force acting at G upward, and the line 3 to 0 gives the downward force at H. Hence we have the figure $a\,a'\,k\,g$ H as the cord polygon of the system of forces. At k is a zero point (see § 132), and for convenience in showing the figure it is preferable to turn the triangle $k\,g$ H over to the position $k\,g'$ H. The cord polygon thus found will be of service in constructing the surface of moments, as will be seen later. For the determination of the shank A B draw from A on the pressure 1 the triangle $a\,b\,b'$, whose ordinates will serve to determine its dimensions.

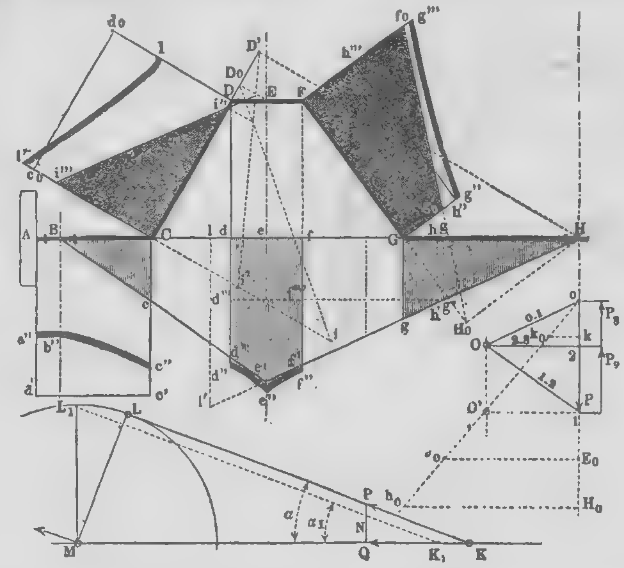


Machine Construction.—Fig. 468.

Crankpin C E D.—This is subject to bending, as shown by the surface of moments $c\,a'\,e$, and to twisting by the force 1 acting as a lever arm $r = \text{C}\,c - \text{B}\,b$. In order to determine the twisting moment, take $a\,l = r$, and draw the ordinate $l\,l'$; this latter will then be the desired moment, and the corresponding surface a rectangle on $c\,e$. Combining this, as before, with the trapezoid $c\,d'\,e$ gives the surface of moments $c\,c'\,d''\,e'\,e$. Should it occur that the only pressure acting is that upon the return crankpin the surface will be modified as follows:—Prolong the line $a\,d'$ to m', and taking this bending polygon, obtain the corresponding surface of moments $c'\,d''\,e$, from which the crankpin C D E can be proportioned. The minimum length l of the crankpin must be that due to the pressure 2, as given before, for overhung journals.



Machine Construction.—Fig. 469.



Machine Construction.—Fig. 470.

Axle F G H I.—This is subjected to bending according to the polygon F $f\,g'$ H, and also to torsion by the moment of the force 2 less that of the force 1. In order to find the first, we choose in the force polygon a second pole O', upon a horizontal passing through the starting point of the force 2,

returning the same pole distance. Draw 2 O″ and make $d\ g''$ parallel to it, make $d\ n$ = C c = R, and we have in the ordinate $n\ n'$ the desired twisting moment. Make the abscissa of the ordinate at $a' = A\ a = R - r$, and this ordinate will then be the moment with which the force 1 twists the arm backward. Taking this from $n\ n'$ gives the height F f' of the torsion rectangle F I $i'\ f'$, which we may combine with the bending surface in the manner already given, and thus obtain the surface of moments F $f_0\ g''$ H $h''\ i''$ I. Should the case occur in which the force 1 becomes zero, as is the case at some points in steam engines when the return crank operates the valve motion, we have for a bending surface F $f_0\ g''$ H, and for a torsion surface F $F_0\ i$ I, which gives a surface of greater ordinates to be used. Such a case is given in unlettered dotted outline shown upon the base F I. It is assumed that the portion H I is subjected only to the action of a torsion couple, hence the polygon there becomes a rectangle.

Return Crankarm B C.—This is subjected to torsion by the force 1, with an arm A A_0 perpendicular to C B prolonged (its moment being equal to the ordinate at a_0), and to bending by the arm A_0 C, whose polygon is a triangle on C A_0 and angle at A_0 equal to $l\ a\ a_0$. The reduced surface is shown at C B $c_0\ c''$.

Main Crankarm E F.—This is subjected to bending forwards with a moment surface D_0 F F″, the angle at D_0 being equal to $e\ d\ g''$, and to forward twisting with an arm D D_0, which is perpendicular to F E prolonged; it is also subjected to backward bending by the force 1, with a surface E_0 F F′, and backward twisting by the arm A E_0 normal to F E. The combined bending moments give the surface E $d_0\ e_0$ F‴ F, and the combined twisting moments the rectangular shown upon E F, the combination of both resulting in the final surface E $e'''\ f'''$ F. Should the force 1 become zero the figures will be increased to that shown by the dotted lines.

§ 171.

THE SIMPLE CRANK AXLE.

Crank axles may be divided into simple and multiple cranks. A simple crank axle is shown in Fig. 469.

The analytical discussion of such a crank axle is such a complicated matter, and the practical results are so readily obtained with all needful accuracy by the graphostatic method, that the latter is only given here. In Fig. 470 is shown a skeleton diagram A B C D E F G H of a crank axle with both arms inclined.

If we make the value of the force P, which acts upon the crankpin, equal to Q when it acts in the direction K M, it will be equal to $\frac{Q}{\cos \alpha}$ when the connecting rod is in any inclined position K L; α being the angle of the rod with the axis K M. For a constant force Q the pressure P will be a maximum when K L acts normal to L M, and this is so nearly the same as the value for the vertical position M L_1 of the crank or $\frac{Q}{\cos \alpha_1}$, that this latter may be taken for the graphical examination without a closer determination. The force at M is equal to P in magnitude, and also parallel in direction, and at K is a normal pressure, which is $N = Q \tan \alpha$, and is a maximum for the position $K_1\ L_1$ M. Hence we may safely assume that the moments with which the crankarms and the axle are bent attain the maximum at the same time, and are those due to the force P. In the example the crankpin is at E, at B and H are bearings, at A is a couple by which the shaft is subjected to torsion due to the force P acting with a lever arm R. This problem is very similar to the preceding, the portion H G taking the place of the return crank, with the difference that the force at H is variable and indeterminate, but is dependent upon the pressure P at E.

Force Polygon.—In order to make the closing line of the polygon horizontal, draw the line B e' to any desired point e' on the normal E e', join e' with H; then on any convenient scale draw the force P from O, in the diagram on the right, and make 0 O parallel to H e', 1 O parallel to B e', and O 2 normal to P. Then the distance 1 to 2 is the upward force P_2 acting at B, and 2 to 0 the force P_3 at H, O_2 being the pole distance.

Axle Shank H G.—This is subjected to bending by the force P_3 at H. The triangle H G g is the surface of moments, and the ordinates may be used to determine the dimensions of the journal at H.

Axle Shank B C.—The surface of moments for bending is the triangle B C c. In addition to the bending is the twisting moment P R; in order to determine this make O′ 1 normal to P and equal to O 2, and also make $E_0\ e_0$ parallel to O_2 and equal to R, then $o\ E_0$ is the desired moment, which, laid off at C c' and A a' and combined with B C c in the manner already described, gives the surface of moments A B C $c''\ b''\ a''$.

Crankpin D E F.—The surface for bending moments is the figure $d\ f\ f'\ e'\ d'$. For twisting we have the force P_3 at H, with a lever arm of E e = R. Make H g = E e = R and the ordinate $g\ g'$ is the desired moment, which, transferred to $f'''\ d'''$ and combined with the preceding surface, gives the surface $d\ f\ f''\ e''\ d''$. The greatest ordinate $e\ e''$ should be used if the pin is to be cylindrical.

Crankarm G F.—Draw E D_0 parallel to H D′ normal to C D. We then have forward bending by the force P at D_0; backward bending by P_3 acting at D′. The cord polygons for these are, the triangle D_0 C i (with C $i = o$ H_0 in the force polygon, where $H_0\ h_0$ = C D_0), and D′ C′ i; which when combined give the surface C $i''\ i'''$ for the bending of the arm D C. We also have a forward twisting from the force P with the arm E D_0 = $k\ k_0$ in the force polygon, and the moment $o\ k$ acting backward from the force P_3 with a lever arm H D′ = H l in the cord polygon and a moment $l\ l'$. The difference between these moments laid off at D d_0 and C c_0 and the resulting torsion rectangle combined with the bending triangle gives the surface C D I I′, so that all five portions of the diagram now have their moment surfaces determined. The method of using these for the determination of dimensions is the same as before.

(To be continued.)

The Iron and Steel Institute.

(*Continued from page* 218.)

THE ELIMINATION OF SULPHUR FROM IRON.

The first paper read was by Mr. J. E. Stead, of Middlesbrough, "On the Elimination of Sulphur from Iron." It formed a continuation of a paper submitted at a previous meeting. Since the first part was read the author had conducted special experiments to ascertain the exact nature of the change which occurred when fluid oxides of iron acted upon fluid iron containing sulphur. The imperfect trial described in the previous paper tended to show that, provided the cinder was not charged with any large quantity of peroxide of iron, no gas having a smell of sulphurous acid was given off; but as this was not conclusive, a more careful and elaborate experiment was conducted, which he thought was more satisfactory. As a result of this test, it would appear that no sulphurous acid was formed directly by the oxidising action of protoxide of iron on the sulphur in fluid iron, but that sulphur existing as sulphide in the iron was found in that state in the cinder. The next question to answer was whether the sulphur was absorbed directly as such, or that sulphide of iron was dissolved out of the metal by the oxides of iron. An experiment was made in which sulphur vapour was passed through ferrous silicate. It appeared from this test that basic silicate of iron was capable of absorbing free sulphur; but whether it had the power to withdraw sulphur from sulphide of iron in fluid metal (taking the sulphur and leaving the iron) was a question which required further investigation. The author considered that the most probable reaction was, that as basic silicates freely dissolve sulphide of iron, that substance was bodily dissolved out of the iron, and that in the puddling process the sulphur was afterwards partially converted into SO_2 by oxidation, and escaped in that state.

DESULPHURISING IRON AND STEEL.

A paper on "A New Process for Desulphurising Iron and Steel," by Mr. E. H. Saniter, was next read. This was supplementary to a paper presented at a previous meeting, and the author, after six months' further experience of the process, affirms what he had previously stated. The process is adapted either for purifying fluid pig iron direct from the blast furnace, by running the fluid metal into a ladle having a layer of the purifying materials on the bottom, and afterwards running the metal into "pigs" or "plate metal" for subsequent use in the puddling furnace, etc.; or the crude sulphury pig is treated in the basic Siemens furnace or Bessemer converter with the patented mixture. The purifying material is calcium chloride in admixture with lime. A plant on this system has been laid down at the works of the Wigan Iron and Steel Company for dealing with the whole make of a blast furnace. The plant and general arrangements are as follow:—The sand bed has been lowered to the ground level; on this level, and in front of the blast furnace, is a ladle on a carriage, the ladle being provided with tipping gear. The ladle is heated before the first operation, and the mixture then put on the bottom, a small cast-iron plate being used to prevent the molten metal cutting under the mixture. The metal is then run in, and as soon as the reaction ceases is tipped into the lowered sand bed and the slag raked out of the ladle, which is then ready for the next operation. This ladle treats from nine to twelve tons at a cast. Out of twenty consecutive results as to the amount and regularity of desulphurisation obtained, the following may be quoted, the first figures showing the percentage of sulphur before treatment, and the second after treatment:—(1) 0·248 and 0·074; (5) 0·134 and 0·059; (10) 0·124 and 0·061; (15) 0·082 and 0·039; and (20) 0·098 and 0·025 per cent. respectively. The cost of materials is 4d. per ton on these charges, and the other costs, including labour and grinding, have been found to be under 2d. per ton.

RECORDING THE TEMPERATURE OF THE HOT BLAST.

A paper on "The Recording Pyrometer," by Prof. W. C. Roberts-Austen, was next read. The author pointed out that much interest had been taken in recent developments of electrical methods of measuring high temperatures. The merit of showing that thermo-junctions could be readily employed for measuring high temperatures belonged to A. C. and E. Becquerel; gratitude was due to Barus for recent work in that direction, and it was to the advocacy of M. H. le Chatelier that the recent adoption of thermo-junctions was due. The advantages of the latter's thermo-junction were first publicly demonstrated in England at the British Association meeting in 1889, and Sir Lowthian Bell was so impressed with the desirability of applying it to the measurement of the temperatures of blast furnaces that he adopted it at the Clarence Works. In 1892 Mr. C. Bell communicated to the Cleveland Institution of Engineers a paper in which some curves were plotted, giving the results of measurements of the temperature of the hot blast supplied to certain furnaces. He also described a novel application of the thermo-junction to the indication of the *time* at which the successive changes were introduced into the furnace. As regarded the measurement of the temperature of the blast, the author said that photography had already done excellent service in affording him a means of recording changes in the behaviour of alloys during thermal treatment. He considered it evident that it could also be employed for autographically recording the changes of temperature either in the hot blast or in any locality in which the thermo-junction might be placed. For this purpose the recording pyrometer which was described at the Liverpool meeting in September last was devised, and the object of the present paper was to give information as to the efficiency of the apparatus, which had been and was still used by Mr. E. P. Martin at the new Dowlais Works at Cardiff. Mr. Martin had made preparations on a liberal scale for the installation of the instrument; no less than 360yds. of wires were laid down for connecting the furnaces with the galvanometer, and the thermo-couples were in the first instance introduced into the horseshoe main of a blast furnace. The mode of inserting the thermo-junction was a matter of some importance. The initial difficulties were soon overcome, and the results showed that the anticipation that the "recorder" would prove a valuable adjunct of iron and steel works was amply justified, as was shown by the curves obtained by its aid and submitted to the meeting.

The first plate of curves represented a record for 23½ hours of the temperature of the hot blast supplied to a furnace by a series of stoves. It was a typical record, and represented an example of careful and successful gas-firing. The record showed that the temperature never rose above 1400° F. or fell below 950° F., and that good, conscientious, careful firing took place, such as should ordinarily be obtained in works. Complications are, however, introduced by untoward accidents, and the second plate had been specially selected as indicating the existence of conditions which presented much difficulty—as, for instance, leaky valves,—and which was soon overcome. The importance of a constant temperature of the blast was manifest. It was not only desirable to measure the temperature of the blast, but also to be able to observe the temperature at any given moment. In recent forms of the "recorder," a subsidiary mirror diverted the ray of light from the drum and threw it on to a divided transparent scale on the top of the camera, so that a direct observation of the temperature could be made without seriously interrupting the progress of the photographic records. By watching the progress of the record, it was often possible to diminish the amount of fuel charged into the furnace, and thus effect economies which might attain large proportions. Among the advantages claimed for the appliance may be mentioned: (1) That a check is placed on the gasmen, and to a less extent on the men at the furnace top; (2) inferences may be drawn as to the conditions which prevail in the interior of the furnace; (3) accurate information may be gathered as to the time of reversal of the valves and of casual admission of cold blast; and (4) certain indications afforded by the curves show that changes have been effected in the accessories of the blast furnace, such as the removal of tuyères, alterations in breastplates, etc.

Mr. Martin, who spoke highly of the instrument as used at the Dowlais Works, stated that possibly important results might be obtained later on by its application to recording the temperature at which steel was cast from the ladle into ingots or moulds, as he had reason to believe that this point had a great deal to do with explaining, to some extent, some of the uncertainties and difficulties met with in the behaviour of steel when finished.

(To be continued.)

Shipbuilding Notes.

Messrs. Wm. Doxford and Sons, Sunderland, have received an order for a steamer of the "Turret" type, from Messrs. Peterson, Tate and Co. Limited, of Newcastle-on-Tyne.

The shipbuilding returns for Baltimore and its immediate vicinity, for the year 1892, show considerable increase. During the year 67 vessels have been launched, with tonnage amounting to 12,000 tons.

A steel screw steamer was launched on the 30th ult. from the shipbuilding yard of Messrs. Hall, Russell and Co., Aberdeen. The dimensions are:—Length, 271ft.; breadth, 36ft. 6in.; depth, 25ft.; gross tonnage, 1950 tons. Triple-expansion engines of 190N.H.P. are to be fitted.

On the 1st inst. the new submarine boat "Le Zede" was launched from the Mourillon Yards, Toulon, France. The installation of the electric motor was completed on board, and the vessel was twice plunged beneath the water, the experiment being a complete success on each occasion.

Messrs. David J. Dunlop and Co., Inch Works, Port-Glasgow, have contracted to build a screw tug steamer, to the order of Messrs. A and W. Dudgeon, London, for service on the river Thames. This steamer will be supplied by the builders with specially powerful engines for towing purposes.

On the 30th ult. Messrs. Wigham Richardson and Co. launched from their Neptune Shipyard, Newcastle, a steel screw steamer. She is 275ft. in length by 35ft. beam. The engines are of the triple-expansion type, and they, together with the boilers, have also been constructed by Messrs. Wigham Richardson and Co.

On the 30th ult. Messrs. Ropner and Son launched a steel screw steamer of the following dimensions, viz.:—Length between perpendiculars, 315ft.; breadth, 40ft. 6in.; depth, moulded, 23ft. 7in. She will be fitted with triple-expansion engines by Messrs. Blair and Co. Limited, of 1200I.H.P., with two large steel boilers, working at 160lb. pressure.

On the 30th ult. Messrs. R. Craggs and Sons launched from their Middlesbrough yard a steel screw-steamer of the following dimensions:—Length, 170ft.; breadth, 27ft.; depth, moulded, 13ft. 8in. She will be fitted with triple-expansion engines by Messrs. Westgarth, English and Co., of Middlesbrough, having cylinders 13, 21, and 34in. diameter by 27in. stroke, with a boiler 11ft. 9in. by 10ft., working at a pressure of 160lb.

On the 31st ult. Messrs. Richardson, Duck and Co. launched from their yard at Stockton a steel spar-decked screw steamer of the following dimensions:—Length over all, 357ft. 6in.; breadth, extreme, 43ft.; depth, moulded, 29ft. 9in.; tonnage, gross, about 3600 tons. The engines will be fitted by Messrs. Amos and Smith, of Hull, having cylinders 24, 38, and 64in. diameter by 42in. stroke, steam being supplied by three single-ended boilers, working at 180lb. pressure.

On the 31st ult. there was launched from the yard of the Naval Construction and Armaments Company, Barrow, the steamer "Accra," built to the order of the British and African Steam Navigation Company, Glasgow. She is 336ft. long, 39ft. 3in. beam, and 25ft. moulded depth. The vessel will be fitted with triple-expansion engines, having cylinders 23, 38, and 63in. diameter by 42in. stroke, capable of developing 1600H.P., which will drive the steamer at 11½ knots loaded.

Hydraulic Lifts.*

Having been engaged for many years in the construction and working of lifts of various kinds, the author proposes to place the results of his experience before the society in the hope that the information conveyed may be of practical use to the members. Although he proposes dealing mainly with hydraulic lifts, he thinks it desirable to introduce the subject by a brief reference to lifts of other kinds and of lighter character. He need hardly point out that there is an almost endless variety of hand-power lifts, and lifts which are actuated by belting from pulleys or shafting. The latter are generally constructed with worm and wheel gearing, there being three pulleys on the worm shaft, the centre one being half the width of the others and keyed on to the shaft, the two outside pulleys running loose. There are two belts for driving, one open and the other crossed, and as the open or the crossed belt is brought on to the centre fast pulley, the lift is driven up or down. When the two belts are both clear of the centre pulley, the lift is at rest. The balance weight should be considerably heavier than the empty cage, so as to divide the work. Some engineers object to worm and wheel gearing on account of the loss of power by friction; but the worm and wheel has the great advantage that it will not allow the loaded cage to run down. There should, however, be a small brake on the worm shaft, applied automatically when the two belts are on the two loose pulleys, clear of the centre pulley. The office of the brake is to cause the lift to stop exactly at the same place, when the belts are struck off by the automatic stops at the top or bottom of the travel of the lift.

There is one form of power lift which has not had the extended use that might have been expected, considering it has been successfully working for many years. This is the continuous passenger lift, which is constructed with a number of cages attached to powerful steel-pitched chains, at equal distances apart. They are kept continually moving—hence the name,—the cages always ascending on one side of the well-hole and descending on the other. They move at a slow rate of speed, so that the passengers may step in and out of the cages as they pass the various floors, and with a very little practice one can enter or leave with perfect ease. There is no waiting for this lift, as there is always a cage going up or coming down ready for the passenger to step into. No attendant is required, except to look after the driving engine. The continuous lift might be driven by an electric motor, and would make a good form of electric lift, the motor requiring very little attention.

The electric lift has recently been brought into notice in consequence of the facility with which this form of power can now be obtained, but almost of necessity they must have worm and wheel gearing, otherwise the motor has to be very large so as to run slowly, and the cost of the large motor is nearly prohibitory. There are other objections. It is very difficult to get the worm and wheel so truly cut that the cage moves perfectly smoothly, so that slight waves of motion are felt. Further, it is doubtful whether the electric lift can ever be quite as safe as the hydraulic lift—and safety is an absolute *sine qua non* in all lifts, particularly those for passengers. For these reasons the author is strongly of opinion that it will be long before electric power can compete successfully with the almost perfect application of hydraulic power for passenger use. Lifts are becoming more and more a necessity every day; they are not now regarded as luxuries, as they used to be not many years ago, but they have taken their place as labour-saving appliances of great utility, and in a great many instances they are absolutely indispensable.

Of all lifts the most important is that used for passengers, and more attention has naturally been bestowed upon each detail connected with these lifts than upon the details of other kinds. The failure of any important part of a passenger lift may be attended by a serious accident involving loss of life, therefore great care has to be taken that all parts are of ample strength for the work demanded of them. This, of course, is so in all machine design; but where life is directly dependent upon it, special care must be exercised, and many parts may be duplicated simply with this object in view.

The author ventures to say, without fear of contradiction, that at present no mode of actuating a lift surpasses, or, in fact, equals, that of water under pressure. It may be open to discussion whether high pressure or low pressure is superior. High pressure, it is assumed, is obtained by pumping water into an accumulator loaded to give the desired pressure, and low pressure by gravity from a tank fixed at some altitude. Both systems have their peculiar advantages and disadvantages. The high pressure has the advantage that the machines actuated by it are comparatively small, which is a greater advantage than might appear at first sight. The pipes also are small, and can be run without attracting attention in positions and places where the large pipes necessary for the low pressure would be most unsightly and almost inadmissible; and where, as in most parts of business London, the high-pressure water can be obtained from the Hydraulic Power Company's mains, at a very reasonable charge, the high pressure is far the best. But although there are a few other towns fortunate enough to possess the same facility, such as Liverpool, Birmingham, Hull, etc., yet there are many more which depend upon the low pressure from the ordinary street mains, or must produce the pressure for themselves by pumping either into an accumulator or into a tank, and the question has to be decided which is the best. If there is only one lift to be worked, then in most cases it is preferable to pump into a tank placed as high as possible. If many machines have to be driven, then an accumulator and high-pressure pumps are to be preferred. But each case must be considered and decided separately, sometimes one and sometimes the other system being best suited for the case; no hard and fast rule can be laid down as to which is the best in all cases.

The advantages of the low-pressure system are quietness and that when a tank is used for the water supply it can be large enough to hold sufficient water for the lift to make several trips after the pumps have stopped working. The disadvantages are the large space occupied by the machinery and pipes and their unsightliness, also the extra cost due to their size. On the other hand, the cost of the high-pressure pumps and accumulator would often be more than that of the low-pressure pumps and tanks, including the larger pipes and machines. Both systems will work satisfactorily. In some cases the low-pressure tanks and pipes are fitted with fire hydrants, and afford a certain amount of protection against fire.

Some idea of the advantage of the Power Company's high-pressure water may be obtained by the following simple calculation: Their charge is £20 for 100,000gals. of water used in one quarter; the pressure is at least 700lb. per square inch, and the energy stored in the water amounts to about 1,610,000,000ft.-lb. £20 would pay for 600,000gals. of town water at 9d. per 1000gals. (a fair average price), and assuming 50lb. pressure per square inch, would represent about 690,000,000ft.-lb.; there would therefore be a gain of 920,000,000ft.-lb. by using the Power Company's water, or a saving of about 57 per cent.

(To be continued.)

* Paper by Mr. Robert Carey, read before the Society of Engineers.

Scotch Shipbuilding in May.

The Scotch shipbuilding record for May reveals a slightly better output. The total is better than it has been for some time, and several of the vessels that go to make it are distinctly above the common run. But big productions are in a way natural to summer months, and when, as in this instance, they are unaccompanied by a counterbalancing batch of orders, the result is an activity which is the very opposite of encouraging. As it is, June sees the work on hand considerably diminished, and the prospect of an improvement—to put it as favourably as possible—not any brighter. More contracts were arranged, of course, than were intimated; but the prices, which are, after all, the important thing, were at the same unprofitable level. The best of the contracts went to the lower reach of the Clyde. Messrs. William Denny and Brothers, of Dumbarton, booked an order for two large steamers with which the Union Company of New Zealand propose, it is stated, to begin their new American business. Messrs. Scott and Co., Greenock, are to build a screw steamer of 1250 tons for Messrs. J. and J. Denholm, Greenock, and a steam yacht of 285 tons for Lord Carnegie. A sailing ship of 1600 tons is to be built for Messrs. Crawford and Rowat, Glasgow, by Messrs. Russell and Co., Greenock; and a screw tug steamer for Messrs. A. and W. Dudgeon, London, by Messrs. D. J. Dunlop and Co., Port-Glasgow. Messrs. W. B. Thompson and Co. Limited, Dundee, contracted to build a steel screw steamer, 240ft. by 32 by 15, for Messrs. James Rankine and Son, Glasgow. The vessel is for the Grangemouth and Rotterdam service.

Scotch shipbuilders launched 27 vessels, of 30,116 tons, of which 17, representing 20,008 tons, were steamers, and 10, measuring 10,108 tons, sailing vessels. Of the latter, 3 were small racing yachts, 1 was a barge of 8 tons, and 2 were barquentines of under 1000 tons. Only 3 of the steamers were over 4000 tons, and 10 were under 500. To the total the Clyde contributed 15 steamers, of 19,198 tons, and 7 sailing vessels, of 5921 tons; the Forth 2 steamers, of 810 tons, and 2 sailing vessels, of 3900 tons; and the Tay—or rather Montrose, which is included in the Tay return—a barquentine of 287 tons.

The Amalgamated Society of Engineers.

The forty-second annual report of this society has just been printed. The income for the past year was £245,667 4s. 10¾d., the largest amount realised in any year of the society's history, and £55,893 6s. 8d. over the preceding year. The expenditure for the year was £268,576 8s. 5d., the principal items being out-of-work donation, £116,664 19s. 6d.; contingent benefit, £15,981 7s. 11d.; sick benefit, £40,200 10s. 5d.; superannuation benefit, £47,388 8s. 2d.; accident benefit, £1900; funeral donations, £11,387 9s. 6d.; benevolent grants, £4333 6s. 8d.; working expenses, £15,834 6s. 3d.; grants to assist the trade, £2029 11s. 4d.; to assist other trades, £1964. The balance on hand at the end of the year was £214,344 5s. 11½d., or £3 0s. 5½d. per member, as against £237,251 9s. 5½d. or £3 6s. 7½d. per member the previous year. The principal items of expenditure since the society was instituted in 1851 are:—Out-of-work donation, £1,718,144; sick benefit, £799,228; superannuation, £616,657; accident benefit, £58,042; financial donation, £244,996; benevolent grants, £79,618; assistance to trades, £105,775—total, £3,622,460. At the beginning of the year there were 509 branches and 71,221 members; the year closed with 522 branches and 70,909 members; 4532 members were admitted during the year, and 3515 excluded.

In his annual report, Mr. John Anderson, the general secretary of the Amalgamated Society of Engineers, says that the eight-hours question is undoubtedly the question of the hour. With regard to the general policy of the society on the question, he explains that no definite action has been resolved upon, but members might rest assured that every point was being narrowly watched. When the proper time arrived, no doubt a vigorous policy would be pursued, and he very much mistook the members of the A.S.E., which was the pioneer of the nine-hours movement, if any opportunity of still further improving their position in that respect would not be taken advantage of.

Catalogues, Price Lists, Etc.

Engineers, Tool Makers, Metal Merchants and others are invited to forward Catalogues, Pamphlets, Circulars, Price Lists, etc., for notice in this column.

From the Worthington Pumping Engine Company, Queen Victoria-street, London, we have received a copy of the latest edition of this well-known firm's general catalogue of Steam Pumping Machinery. An immense variety of Worthington pumps are illustrated, accompanied by the necessary particulars as to duty, sizes of cylinders, pipes, etc. The Worthington condenser is also fully described and a number of its applications illustrated. The Worthington marine feed-water heater is fully described, as are also various arrangements of compound and triple-expansion pumping engines, water meters, etc. It should be added that much useful hydraulic memoranda are appended, rendering the book of great value to all who are in any way concerned with water-power calculations of pumps and pumping. We should mention that the book is coded throughout and is neatly printed and bound.

Messrs. Hartcliffe and Malkin, St. Simon-street, Salford, have sent us a circular descriptive of their improved Sight-feed Lubricator. The apparatus is shown variously arranged for single, double, and quadruple feeding.

From Messrs. R. Hunt and Co., Earls Colne, Essex, we have received a copy of their 1893 catalogue, which contains a number of illustrations and particulars of plummer blocks, couplings, hangers, shaftings, standards, collars, pulleys, etc. Prices are given throughout.

Trade Notes.

Messrs. R. Laidlaw and Son, Glasgow, are to supply the 24in. pipes required at the Dawsholm Gasworks.

Messrs. Vernon and Guest, Alma Works, Soho, Birmingham, have just despatched six compound engines to China.

Messrs. Holborrow and Co., Dudbridge Ironworks, Stroud, have completed a large pair of pumping engines for the Stroud Water Company.

The Commentor and Saint-Chamond Steel Works, France, have received an order for 700 sets of wheels from the Western Railway Company.

Messrs. D. Y. Stewart and Co., Glasgow, have secured the contract for the 42in. cast-iron pipes and special castings for the new gasholder at Temple Gasworks.

The directors of Messrs. G. Kynoch and Co. Limited recommend a dividend at the rate of 10 per cent. on the preference shares for the year ended March 31, 1893.

The Normanby Ironworks Company have purchased the cement works at Paradise, South Benwell, and will manufacture there the Hoyle-Robson brand of cement.

Messrs. D. Kimberley and Sons, High-gate Toolworks, Birmingham, have acquired the business carried on in that city by Messrs. Martin and Shaw, plane manufacturers.

Messrs. John H. Hackworth and Co. have succeeded to the business of the Machinery and Hardware Company Limited, which will in future be carried on at 46, Queen Victoria-street, London, E.C.

The directors of the King's Norton Metal Company Limited announce a dividend of 7 per cent. on the preference shares and 2 per cent. on the ordinary shares for the year ended March 31, 1893.

The contract for the supply and erection of a central station switchboard and necessary apparatus at the North-road Central Station, Brighton, has been secured by Messrs. Goolden and Co., Harrow-road, London, W.

The Shilbottle Colliery Company, of Ledbury, Northumberland, have placed a contract with Messrs. Ernest Scott and Mountain, electrical engineers, Newcastle-on-Tyne, for an electrical pumping plant for their colliery.

It is stated that Messrs. David Colville and Sons, Dalziel Iron and Steel Works, Motherwell, have been invited to prepare estimates for specifications amounting to about 10,000 tons of steel for the construction of two large battleships.

The Dowson Economic Gas and Power Company Limited, of London, have received an order from the Midland Railway for a set of the Dowson gas plant to work with ordinary gas coke, for about 200 brake horse-power, for lighting the new station at Leicester. The engines will be supplied by Messrs. Crossley and Co.

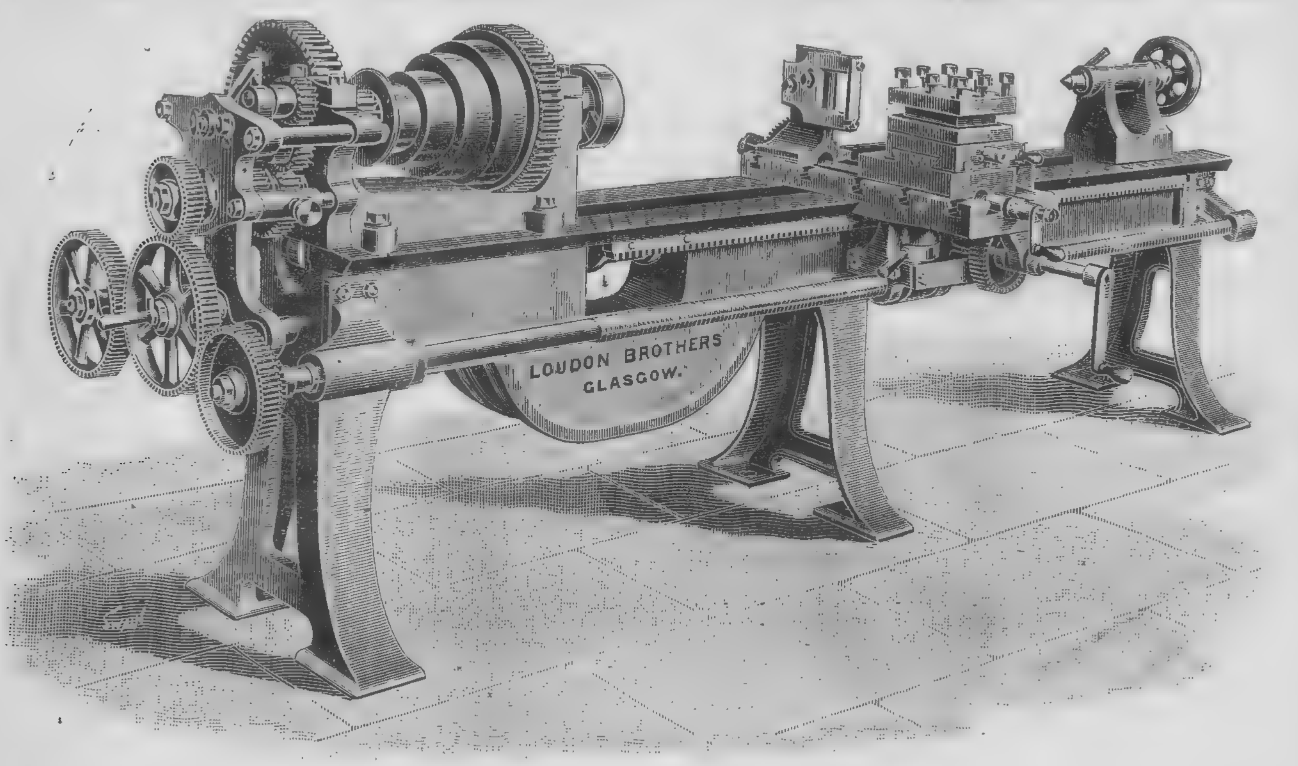
The fuel economisers to be put down at the electric-light installations at Kingston-on-Thames and Sheffield are to be of the improved type made by the well-known firm of Messrs. E. Green and Son Limited, Manchester and Wakefield, whose works at the last-named city are fully occupied in the construction of this speciality for economising fuel.

The Cleveland iron masters' stock returns for May, issued on the 3rd inst., are disappointing, the decline of 2554 tons not being a third of the reduction expected. This arises from a smaller shipment than estimated of Cleveland iron as compared with hematite. The production was 234,000 tons, of which 113,000 tons were hematite, etc., and the remainder Cleveland iron. Stocks are 193,000 tons—an increase of 119,000 tons in the last six months. There were eighty-six furnaces in blast—one less than in April.

We are informed that the new firm of Messrs. Pott, Cassels and Williamson have now completed arrangements for the acquisition of several acres of the Duke of Hamilton's property in North Motherwell, near Glasgow, for the erection of extensive engineering works and an iron and brass foundry. We understand they purpose undertaking a general engineering business, in addition to their specialities, which will include Weston's centrifugal machines, and hydro-extractors for the sugar, chemical, and textile industries. They will also supply sugar machinery generally as used in the Colonies and the refineries at home.

Improved Screw-cutting Gear.

HEREWITH we give an illustration of a 9in. centre self-acting sliding and screw-cutting lathe, with a gap bed 12ft. long, made by Messrs. Loudon Bros., Johnstone, Glasgow. The chief feature of novelty lies in the system of gearing up the change wheels for screw-cutting, this being the invention of Messrs. Robertson and Loudon. The swing plate for carrying the gear between the leading screw and the driving pinion is pivoted on a stud, which carries the driving pinion instead of turning on the screw. There are also two wheels, 80 and 40 teeth respectively, carried on a fixed stud on the swing plate, the 80-teeth wheel being in constant gear with the driving pinion connected to the spindle of the lathe, the 40-teeth pinion on the same stud being utilised for compounding the wheels with the screw for fine pitches. By this arrangement any wheel from 20 to 120 teeth on the screw can be geared without change of intermediates, and provision is made whereby, with six change wheels, all Whitworth standard pitches of angular thread can be screwed of diameters from ¼in. to 3in., three different pitches being screwed by each of the six change wheels without altering their position. Coarse pitches can also be screwed with equal facility. Provision is also made for giving the lathe a fine boring feed suitable for opening a hole in solid metals, and is likewise capable of giving two different feeds without change of wheels. Another feature is an improved turret rest for four tools, suitable for performing ordinary work between the centres of lathe, as well as chuck work—for screw-cutting this is a desideratum, as a roughing-out tool and finishing tools are fixed and do not require to be removed, except for sharpening. It is claimed that by the adoption of the improved method a very great saving is effected in time in the working of the lathe, and an alteration from one pitch of screw to a finer or coarser becomes a very simple matter.



IMPROVED SCREW-CUTTING GEAR.

The Chicago Exhibition.—II.

BY OUR SPECIAL REPRESENTATIVE.

The Boiler Department.—The boilers in use for supplying power to the various exhibits in the Mechanical Arts Building (Machinery Hall) and others are composed entirely of the water-tube type, and with a few exceptions do not present features of very much interest. There are in all over 40 boilers by seven different makers, and they are divided into batteries of two each. The whole system is fired by Armstrong's oil-gas.

Starting from the left-hand end looking from the Mechanical Arts Building, the first boilers worthy of notice are those of the Abendroth and Root Boiler Manufacturing Company, New York. On reference to Fig. 3, which represents a sectional view in perspective of one of these boilers, it will be seen that the general design consists in a group of inclined water tubes, which are in connection at both ends with a series of horizontal overhead drums. The water level is maintained at the centre of these drums. The firing is applied under the raised front ends of the tubes, thus causing an upward flow through the tubes, which, in its turn, causes a downward flow of cooler water from the rear end of the horizontal drums into the lower ends of the tubes; and, by this means, a continuous circulation is kept up throughout the system. The steam collects in the upper portion of the drums. It is claimed by the makers that steam can be raised from cold water in 20 minutes, and this without in any way straining or injuring the boiler. The illustration shows one of the smallest sizes made, having only 10ft. tubes, and averaging about 30H.P. The largest size has 18ft. tubes, and varies from 113H.P. to 313H.P. There are in all 72 standard sizes. Many of these boilers have been working for a period of five years at a pressure varying from 225lb. to 250lb. per square inch, without a hitch of any kind.

Passing on to a somewhat different, and, at the same time, one of the most favourite makes of American water-tube boilers, we have the Stirling safety boiler, manufactured by the Stirling Company, Chicago. This boiler (see Fig. 4) consists simply of two or more upper wrought-steel drums, connected with each other and with a lower or mud drum, also of steel, by tubes expanded directly into the drums. The tubes are divided into sets, each set being expanded into a separate drum. This is to allow for any general expansions and contractions throughout the boiler, while the curiously-shaped bends in the tubes themselves provide for any unequal expansions in the tubes individually. The nearly vertical position of the tubes naturally allows the precipitation of the greater portion of the sediment, and other impure matters, which would otherwise form on the inner surfaces of the tubes as scale. It falls into the mud drum, from whence it can easily be removed by blowing through at intervals. The rear overhead drum receives the feed water, as shown in Fig. 4, the consequence being that nearly all the sediment is got rid of in descending this hindermost group of tubes, meeting, as it does, the ascending heated gases. Thus, on entering the second and third groups of tubes, the water is nearly chemically pure. Many of these boilers have been in use for periods of six months without requiring any cleaning. To provide for a thorough overhaulage, however, there is one manhole in each drum, whereby access can be gained to every part of the interior. The absolute safety of these boilers against explosions of a dangerous character is amply verified by the fact that, in one or two instances, they have run with hardly any water in the boiler and a large fire in the furnace, the only result being the burning away of the tubes in the front group. This would, of course, at once relieve the pressure. The apparent advantage of this type of boiler over most others—such as the Abendroth and Root boilers—is that a most perfect system of circulation is maintained; and this not in any way intermittent or violent, as is the case where tubes of insufficient area form the connecting link between the tubes themselves and the drums. This boiler supplies a separate outlet for each tube equal to its own area—that is, a 100 per cent. outlet,—whereas in most other designs the connecting tube area is not above 10 per cent. to 15 per cent. of the tube area. The makers subject the boilers to a cold-water test of 200lb., and guarantee them for a working pressure not exceeding 150lb. The ratio of heating surface to grate area in a "Stirling" is

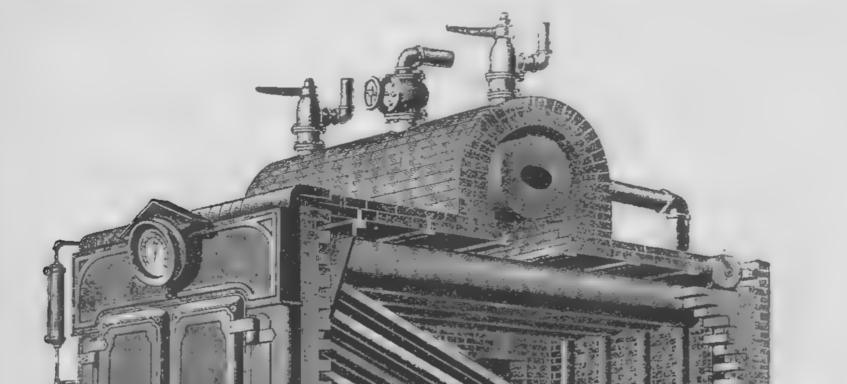


FIG. 3.—THE ABENDROTH AND ROOT BOILER.

FIG. 4.—THE STIRLING SAFETY BOILER.

58·7, while the water actually evaporated per lb. of combustible is claimed to be as high as 9·58lb.

The next boiler which presents some features of interest is that of the National Water-Tube Boiler Company, of New Brunswick (Fig. 5). An exceedingly high evaporation power for this boiler is claimed by the makers, as much as 12·075lb. of water being evaporated per lb. of combustible

One would feel inclined to put this high figure down as the result of priming, but the makers give the percentage of moisture in the steam as only 4·5ths of 1 per cent., which is not by any means excessive.

The rapid circulation of water in this boiler tends to keep the inner surface of the tubes clean, and causes all sediment to be held in suspension in the water until it finds its way to the rear of the boiler, and, finally, is deposited in the mud drum, where the water is less agitated. From here it is expelled through the blow-off pipes. The main difference in construction between this and the Abendroth, described above, is the fact of there being only one overhead drum in the National, whereas there are a series of them in the Abendroth.

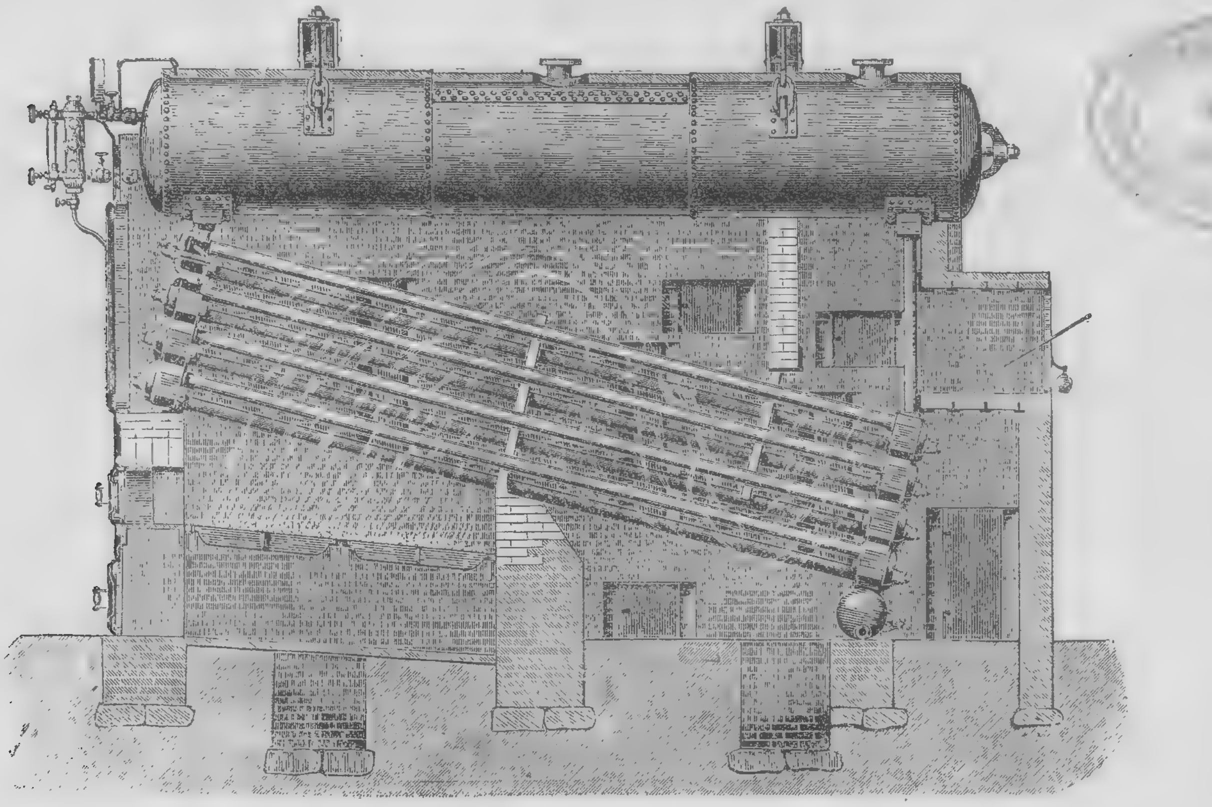


Fig. 5.—The National Water tube Boiler

The only other boiler which has any special individual characteristics is the Heine, manufactured by a firm of that name in St. Louis, Mo.

On reference to the accompanying cut (Fig. 6) it will be noticed that this boiler differs in general design from those already discussed. In the first place, the connection between the overhead drum and the tubes is made by means of a couple of "water-legs." These legs are riveted on to the shell of the drum, and at these two points the drum is cut away to make connection with the interior of the water-legs. The whole boiler is not placed horizontally, but at an incline of 1 in 12 from the rear end. The result of this is to make the water shallow at the front end of the shell, making it easier for the steam to pass through; while its depth at the rear end ensures a solid body of water for replenishing the rear water-leg. The mud drum is situated inside the shell at the lower end, and as the current while passing through the mud drum is only 1/16 of the normal flow, sediment and scale settle down there.

Another favourite boiler, the Gill—manufactured by the Stearns Manufacturing Company, of Erie, Pa.—has some good points, but does not differ sufficiently from the Abendroth or National to require a separate description.

(*To be continued.*)

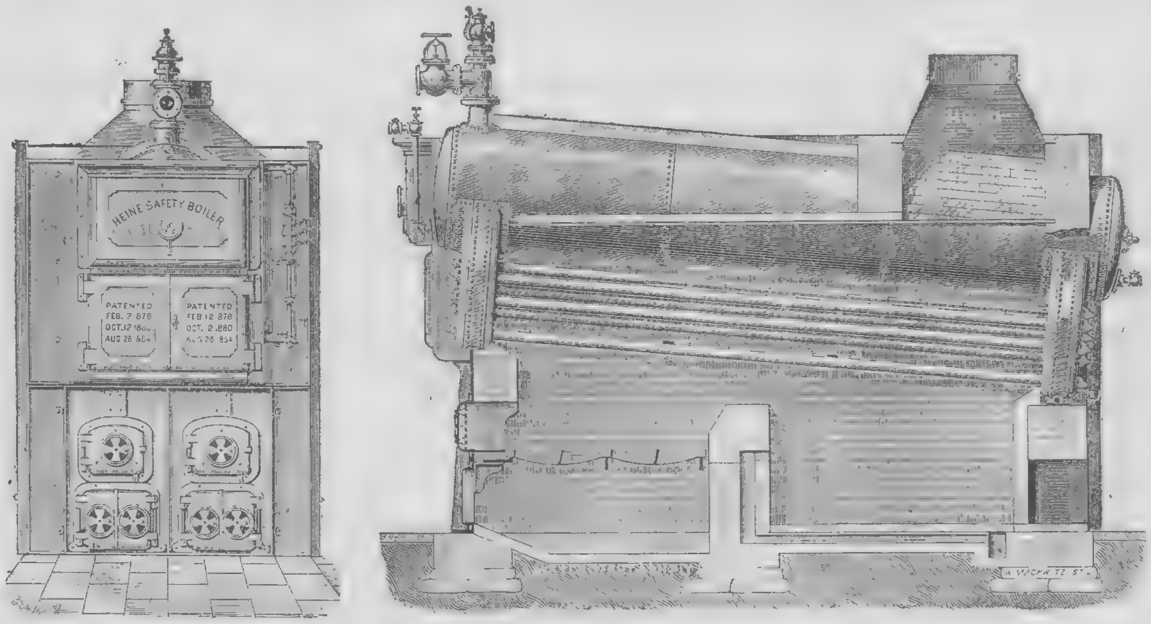


Fig. 6.—The Heine Boiler.

The Dead-meat Freezing Establishments of the River Plate.

By James Durie.

Until within a dozen years or so the work of the engineer and butcher were rather far separated, but now, with the wonderful application of science and mechanics to the supply of the ever-increasing wants of man, we find in the dead-meat trade the engineer and the butcher working in cordial co-operation.

It was in the early part of the year 1885 that the writer, who was then actively employed as an engineer on the construction of the railway between Buenos Ayres and Rosario in the Argentine Republic, paid his first visit to a meat-freezing establishment situated on the banks of the River Parana.

The establishment visited was situated near the town of San Nicolas, and the trade in dead meat was then comparatively young. The situation for such a purpose was a splendid one, even in the days before the opening of the above-named railway, as the Western Railway of the province of Buenos Ayres had a branch line into San Nicolas; thus all the fertile pampas between the River Parana and Mendoza, at the foot of the Andes, a distance of over 500 miles, were available for producing a supply of the raw material, so to speak. Since the opening of the Buenos Ayres and Rosario Railway in 1886, the great plains of the province of Santa Fé have also been connected with the establishment by rail. The water communication is also so good that an ocean steamer can anchor in deep water within twenty yards of the river bank. When the visit to this establishment was made, the killing of sheep for the English market was in full swing, and a steamer of about 1000 tons register was being loaded; but, as above mentioned, this trade was then comparatively young, and there were no freezing compartments on shore. The steamer was fitted up with the Bell-Coleman dry-air refrigerating machines, and had to lie aside for something like a month before she could get her full cargo, consisting of about 40,000 dead sheep.

One day's killing was allowed to hang up to cool during the night in open sheds on shore, and then it was transferred in the cool of the following morning to the cold chambers of the steamer. Of course the freezing machinery on board ship was kept going night and day to preserve the cargo already on board, and would continue to do so until the whole of the cargo was discharged either in London or Liverpool. Since the year named this establishment has been fitted with freezing machines and cold-storage chambers, so that now a steamer can be much more rapidly loaded.

The great difficulty in the trade is getting sheep large enough to suit the English market, as the native Argentine sheep are small. However, the estancheros, or farmers, are beginning to find out that it pays them to breed from improved herds, and the weight of the animals is gradually increasing. Any carcase that does not weigh 60lb. is considered too small to send whole, so only the hind quarters are shipped, the other part of the animal being boiled down for the tallow it contains.

There is another large killing and freezing establishment at Campana, half-way between San Nicolas and Buenos Ayres, also situated on the banks of the River Parana, and close to the railway. But the principal object of this article is to describe the establishment of Messrs. Sansinena, situated at Barras-al-Sud, a suburb of Buenos Ayres, the capital of the Argentine Republic, which establishment the writer frequently visited during the years 1889-90.

Inasmuch as the readers of The Mechanical World are more interested in the mechanical appliances used in such establishments than in the dead-meat trade *per se*, and as the machinery used is of an ingenious and highly scientific character, it may be interesting to go into the mechanical and thermo-dynamical problems involved in dead-meat freezing.

The most successful machines in use until lately have been the dry-air refrigerating machines, which consist essentially of four parts—viz., a steam cylinder with piston for motive power, an air compressor, an air cooler, and an expanding air cylinder and piston. For the present it is not intended to go into the mechanical details of the machine. Steam is supplied to the steam cylinder from boilers in the ordinary way, and there may be two or three steam cylinders for compound or triple expansion; but at the present the writer is not aware of triple expansion being used in these machines, although all the best makers supply compounded engines. Air is drawn into the compressing cylinder at the temperature of the atmosphere, or it may be drawn from the cooling chambers at a lower temperature and compressed to three atmospheres, or 45lb. per square inch. It is obvious that in order to do this, work must be performed, and a part of the heat in the steam cylinder is converted into work in raising the temperature and pressure of the air. The compressed air is raised to a temperature of about 250° F., is passed into the cooler situated in the base of the engine, and circulates through tubes which are kept cold by means of a circulating pump, pumping water through the cooler after the manner of a surface-condenser of a steam engine.

The compressed air has then a temperature corresponding to the temperature of the circulating water, or, say, 60° F., when it is conveyed to the expanding cylinder and made to do work in assisting to drive the engine in expanding down to near atmospheric pressure. Theoretically, at the end of the stroke, air at a pressure of 45lb., and temperature of 60° F., according to Dr. Anderson should be

$$\frac{520^\circ}{\left(\frac{4}{1}\right)^{0.29}} = 348^\circ \textit{ absolute,}$$

which is 144° below the freezing point of water. This theoretical temperature at the Sansinena establishment is nearly attained, as the actual temperature varies from 130° to 140° F. below freezing.

(*To be continued.*)

Society of Engineers.

On the 31st ult., a visit was paid by the Society of Engineers to the waterworks, gasworks, and new front and harbour improvement works, at Ramsgate.

The party were conveyed to Ramsgate in a special train, and were received by the Mayor and members and officials of the Corporation, and were entertained at luncheon at the Water Tower.

Ramsgate Water Tower.

This was erected in 1878 and 1879 to afford a constant supply of water to the town. Up to that date the supply was intermittent, the inhabitants in the upper part of the town not being able to obtain water until the cisterns in the lower levels had been filled. It is built entirely of brickwork, 50ft. by 80ft. on plan and 60ft. high, being surmounted by one of the largest elevated cast-iron tanks in the country, which is 10ft. deep, and holds 250,000 gallons. The weight of the tank is thrown entirely on the cross walls. The whole of the brickwork is composed of common stocks, except the facing of the outside walls, which is Mid-Kent wire-cut red bricks. The pumping main is 15in. diameter, and the distributing main 18in. The water is raised from Whitehall, a distance of about two miles, and pumped into the bottom of the tank, the overflow being in direct communication with the low-level reservoir holding 750,000 gallons. This arrangement obviates the necessity of making any alteration in the valves during pumping hours. The difference in level between the bottom of the well and the top of the Tower is 220ft.

GASWORKS.

These were purchased by the town in 1878. Immediately after the transfer it was found necessary to entirely reconstruct the works. The present capacity is about 200 million cubic feet per annum. The retort house consists of 14 beds of 6 retorts each, and 5 beds of 8 retorts each. Gaseous firing is used throughout, and West's manual machinery is used for charging and drawing. The condensing, scrubbing, and washing apparatus need no special notice in this summary, but it may be mentioned that the purification is accomplished by what is known as the oxygen process. The method of producing the oxygen is as follows:—Air is pumped, under a pressure of about 15lb. to the square inch, into cast-iron retorts, filled with barium monoxide heated to a temperature of 1400° F. At the end of about three minutes after the barium has become peroxidised, the operation is automatically reversed, and the retorts being placed under a vacuum, the barium yields up its extra oxygen and returns to the state of barium monoxide ready for another operation. The oxygen thus produced is stored in a holder and then admitted into the purifiers, causing them to run a much longer time without change, at the same time having a beneficial effect on the illuminating power, and rendering the spent lime inodorous. The gasholders, of which there are two, have a capacity of 650,000 cub. ft. This, in the course of another year, will be supplemented by another holder containing about one million cubic feet.

FRONT AND HARBOUR IMPROVEMENT WORKS.

For the last fifty years the necessity for better communication between the cliffs and the sands had been felt, and various schemes to attain that object had been brought forward at different times; but none, strange to say, until the present one (which was also the first to get the consent of the burgesses), proposed to interfere with the inner basin. The water along the north or Military Wall of the Inner Basin was so shallow as to be of little use for berthing vessels, etc.

The work now being carried out was commenced in January, 1892, and consists of a new basin wall to cut off the shallow part; a rising road from York-street to the West Cliff, on the site of the old Military road; a rising road to the East Cliff; and the pulling down of the Customs House and Harbour-master's house (which will be rebuilt in another position) and the warehouses in the Pier-yard, so as to widen the approach to the L. C. and D. Railway and the sands from the present 15ft. to 60ft.

The sea wall is built of concrete and faced with Portland stone, and coped with granite 18in. deep. The wall is 30ft high, 5ft. 6in. thick at the bottom and 4ft. at the top, with 4ft. counterforts at intervals of 30ft.

The rising road to the West Cliff is carried on semi-circular arches, 30ft. centres. The party walls are of concrete, the lower ones being 2ft. 6in. thick at the springing, and the more lofty ones 3ft. The arches are built of picked stocks, the thickness being 18in.

The front arches are built in red Pluckley bricks, with a moulded cornice and terra-cotta balustrade. The road will have an inclination of 1 in 25. The carriage way will be macadamised and 30ft. wide. The footway will be of asphalt 15ft. wide.

The approach to the East Cliff, to make room for which the Albion Hotel is to be removed, will follow the natural conformation of the ground, and will have an incline of 1 in 14.

The approach to the sands will be paved with wood in place of the present cobbles. The Customs House will be rebuilt on the opposite side of the road, and the Harbour-master's house will be rebuilt on the West Cliff.

Besides these improvements, the small cottages on the north side of Lower Harbour-street will be removed, and the site laid out in ornamental gardens.

The works are being carried out by Messrs. W. and T. Denne, contractors, from the designs and under the superintendence of Mr. W. A. McIntosh Valon, J.P., Borough Engineer.

Metal Trade Memoranda.

The Whitehaven Hematite Company have relighted two of their furnaces at Cleator Moor.

The arrivals of tin during the first four months of this year have been about 1500 tons more than in the corresponding period of 1892.

In the first four months of 1892 we imported 14,175 tons of spelter, valued at £310,903. The return this year is 16,833 tons, value £305,523.

Nineteen mines were in operation in Algeria during the past year—namely, seven zinc mines, five iron mines, four lead mines, and three copper mines.

Referring to the paragraph which appeared in our last issue regarding electro-deposition by a painting process, Mr. Fred J. Hurst, of 124, New Broad-street, London, informs us that only from him can particulars be obtained.

The value of the exports of telegraphic wire and apparatus from the United Kingdom during the first four months of the present year amounted to £435,434, being a large falling off as compared with the corresponding periods of 1892 and 1891, which were £543,962 and £712,307. respectively.

At a meeting of the Midland Iron Trade Wages Board, held on the 29th ult., the accountants reported that the average selling price of hoops, bars, sheets, and plates for March and April had been £6 3s. 7d. per ton, as compared with £6 4s. 6d. for the first two months of the year, and £6 10s. 6d. twelve months ago. It was decided to make no alteration in wages, and it was announced that the Board was under reconstruction to meet the operatives' request that Staffordshire wages should be decided independently of Cleveland prices.

New Companies.

DAIMLER MOTOR SYNDICATE LIMITED.—This company was registered on the 26th ult., with a capital of £6300, in £10 shares, to acquire the business of engineers now carried on by F. R. Simms, at 10, Billiter-buildings, Leadenhall-street, E.C., under the style of "Simms and Co.," to purchase patents, etc., and to continue the business above-mentioned. The first directors are F. R. Simms, R. Gray, and T. Vasmer; remuneration, £50 per annum; managing director, £100 a year extra. Registered by D. B. Lewis, 20, Bucklersbury, E.C., solicitor.

AUTOMATIC CHAIN COMPANY LIMITED.—This company was registered on the 25th ult., with a capital of £20,000, in £10 shares, to purchase from G. H. Gardner the following British patents: 14,732 of 1889; 7752 of 1891; 22,731 of 1891; and 3432 of 1892; and to acquire the business of a chain manufacturer, carried on at 42, Caroline-street, Birmingham, and to continue the same. The first directors are F. S. Bolton, H. Rogers, and G. H. Gardner; qualification, £500; remuneration, £10 per annum for every one per cent. paid by way of dividends for each director. Registered office, 71, Colmore-row, Birmingham.

FOSTER BROTHERS LIMITED.—This company was registered on the 31st ult., with a capital of £30,000, in £10 shares, to purchase and take over as a going concern the works, lands, buildings, plant, machinery, and fixtures known as The Lea Brook Works, at Wednesbury, Stafford, also to purchase the business of tube and fitting manufacturers and galvanisers carried on by H. Foster, J. F. Green, and Jessy Foster, and to continue the trade and undertaking acquired. The first directors are H. Foster and J. Franks; qualification, 100 shares; remuneration of H. Foster as managing director, £500 per annum. The remuneration of the other directors is to be fixed by the company in general meeting. Registered by Jordan and Sons, 120, Chancery-lane, W.C.

The Metal Market.

PRICES CURRENT.

LONDON, June 5.

COPPER advanced 2s. 6d. at the first call, owing to Continental buying orders, three months selling at £43 17s. 6d., but these were freely met, and sales were made at £43 16s. 3d. and £43 15s. Cash then changed hands at £43 5s. to £43 3s. 9d., but rallied to £43 5s in the afternoon, a more hopeful feeling following upon the improvement in the financial situation, and three months was done at £43 15s. The close was firm at previous rates. Sales, 400 tons. Settlement price, £43 5s.; English tough, £46 5s.; best selected, £47 15s.; strong sheets, £54 5s.

TIN opened easy at 5s. decline, and business in three months at £84 5s., but the tone improved on a good inquiry for late prompts in the current month, which realised £85 to £85 2s. 6d. Cash made £85 5s. to £85 7s. 6d., and ruled firm. In the afternoon a line delivery overside from the Canton was put through at £85, and the market closed steady at about Friday's values. Sales, 130 tons. Settlement price, £85 5s. English ingots, £89. Amsterdam market quiet; Billiton, 52; Banca, 52½.

PIG IRON has ruled firm, and business comprises 1000 tons Scotch, one month, at 41s. 1½d.; and an early prompt Middlesbrough, 500 tons, at 34s. 1d. Final rates are unchanged for Scotch and hematite, while Middlesbrough is 1½d. higher. Settlement prices:—Scotch, 40s. 11d.; Middlesbrough, 34s. 2d.; hematite, 44s. 6d.

TINPLATES unchanged, but tending lower. I. C. cokes, f o b. Swansea, 11s. 6d. to 11s. 7½d.

LEAD is quiet and 1s. 3d. cheaper at £9 5s. sellers. English, £9 7s. 6d.

SPELTER has shown an easier tendency, and closes sellers £17 17s. 6d., June shipment.

ZINC SHEETS.—Silesian remain dull at £20 10s., ex ship; Belgian are steady, with V.M. Company's brand at £21 5s. ex ship, and £21 2s. 6d. f.o.b. Antwerp.

OFFICIAL CLOSING QUOTATIONS.

	To-day. £ s. d.	£ s. d.
COPPER—		
G. M. B.—Cash	43 5 0	—43 12 6
" Three months	43 15 0	—44 2 6
TIN—		
Fine foreign—Cash	85 5 0	—85 15 0
" Three months	84 5 0	—84 15 0
Australian—Cash	85 15 0	—86 5 0

PIG IRON—

	Scotch. Cash. s. d.	Scotch. 1 m'th. s. d.	Middlesbrough. Cash. s. d.	Middlesbrough. 1 m'th. s. d.	Hematite. Cash. s. d.	Hematite. 1 m'th. s. d.
Close	40 11	41 1½	34 2½	34 5	44 6	44 8½
Prev.close	40 11	41 1½	34 1	34 3½	44 6	44 8½

GLASGOW, June 5.—Though the Cleveland returns were regarded as unsatisfactory, there was more activity on the pig-iron market, about 10,000 tons of Scotch and 3000 tons of Cleveland changing hands. The dealing in Scotch was chiefly for cash, and at prices varying from 40s. 11½d. to 41s. 0½d. Scotch left off unchanged from Friday, but Cleveland made 1½d. more. Hematite was neglected, and a little off. The shipments of Scotch last week were 6629, an increase on the corresponding week of 1660 tons, thus making the increase for the year 3681 tons.

QUOTATIONS:—

	Scotch. Cash. s. d.	Scotch. 1 m'th. s. d.	Middlesbrough. Cash. s. d.	Middlesbrough. 1 m'th. s. d.	Hematite. Cash. s. d.	Hematite. 1 m'th. s. d.
Highest ..	41 0½	41 2	34 2½	34 6	44 6	44 8½
Lowest ..	40 11½	41 1½	34 2	34 5	44 6	44 8½
Close	40 11	41 1½	34 2½	34 5	44 6	44 8½
Prev.close	40 11	41 1½	34 1	34 3½	44 6	44 8½

Official Gazette.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Receiving Order.

FRANK HERBERT CLARK (trading as Clark Bros.), Dames-road, Forest-gate, E., cycle manufacturer and engineer.

Adjudications.

WILLIAM GLOVER, Leicester, machinist.
JEREMIAH SIMPSON, Bursley, engineer, formerly contractor.

Order made on Application for Discharge.

FREDERICK HALL SNYDER, Winchester-house, Old Broad-street, E.C., and First Avenue Hotel, High Holborn, W.C., late Albert-place, Bedford-square, and Montague-street, Russell-square, W.C., director of the Snyder Dynamite Projectile Company Limited—discharge suspended for three weeks ended May 30, 1893. Public examination concluded December 9, 1890.

Letters to the Editor.

*** *We do not hold ourselves responsible for opinions expressed by correspondents.*

*** *The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

*** *Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

THE CHEMICAL ELEMENTS CONSIDERED AS BEING DIFFERENTIATED ASPECTS OF A SINGLE SUBSTANCE.

To the Editor of THE MECHANICAL WORLD.

SIR,—When iron is burned in oxygen, the two elements combine and form oxide of iron. There is a great liberation of heat. What is the heat? Heat is a motion imparted to the medium by which the hot body is surrounded. In proportion as the medium receives the motion, so does the hot body lose motion. Oxygen, therefore, in combining with iron, loses motion. The motion in oxygen and all bodies is a motion of the atoms of which they are composed. It follows, therefore, that before the act of combination took place, oxygen and iron were at different rates of atomic motion. After combination their rates are equalised.

The elements are distinguished one from another, first, by the colours of their spectrum. Colour, when the atoms of a body are in the rapid state of motion of incandescence, is determined by the waves thrown off by such body. When a body is not in an incandescent condition its colour is due to the extinction of certain constituents of the white light within the body, the remaining constituents of which return to the eye, imparting to the body its colour. When we say, therefore, that we distinguish different elements by their colour, we imply that we distinguish them by the rates at which their atoms vibrate. If, therefore, the rate of vibration of an atom, say of oxygen, be altered, there will occur an alteration in the characteristic spectrum colour of the oxygen.

In dealing with temperature, on this question the mercury standard will not fulfil the requirements, as it does not respond to the extreme limits of cold and heat. We require a standard sensitive to extreme temperatures above and below zero. We might, with such a delicate substance, if it could be obtained, show the great difference in the specific heats and boiling points of gases and metals without recourse to figures.

Great extremes of temperature may quite fail to convey to the human organisation the sensation of heat, just as the pitch of a musical note may be so extreme as to fail to impress the ear as sound.

And only certain lengths of the ether waves will arouse in the eye the sensation, light.* Hydrogen and oxygen in their active gaseous state do not affect the human body as heating substances. Lower their temperature and they boil with great liberation of heat; bring them still lower and they assume the solid form, and in this state again we do not recognise them as heat-givers. Others of the gases behave in a similar manner.

The elements are also distinguished by fully recognised properties which are peculiar to each of them; but by altering the temperature we cause a change in those properties. Oxygen as a gas is colourless, but as a liquid is a pale blue. As a gas it combines readily with sodium and potassium; as a liquid it refuses to do so. Thus many of the elements, on a change of temperature, change those characteristics by which we identify them. We see that the characteristic properties of elements are due partly to various rates of motion to which their atoms are subject. In other words, they are due to changeable conditions of velocity and mass. When two or more elements combine, they lose their individuality—*i.e.*, their properties when as single elements—and in their combined state manifest properties of an entirely different character. Thus there is produced a vast number of compounds which possess properties not displayed by any one single element. Now, considering how large are the number of compounds which are built up from a small number of elements, it is reasonable to suppose that these elements may be themselves built up from a still more limited number of *ultra* elements. The elements of the chemist might be resolved into such ultra elements by extremes of temperature, sub-division, and conditions which, though not attainable at present on our planet, *have* existed, and *do* exist elsewhere upon other planets than ours. Another means of distinguishing elements one from another is by their atomic weights. Now when we are told that the elements unite in proportion to their atomic weights, we are impelled to ask, Why should the earth's gravity-pull (for all units of weight are calculations of the earth's pull on some body selected as a standard—as hydrogen or water) have a controlling influence on the proportions in which elements shall combine? The fact is that it is *mass*, not weight, that determines the proportion in which elements combine; and when two atoms of hydrogen combine with oxygen to form water, a small *mass* is mixed with a larger *mass*. It is just because equal volumes of substances are not necessarily equal masses that chemists find it convenient to calculate combining proportions by atomic weight. Gravity acts upon matter with a strength proportionate to the mass acted upon. If oxygen is 16 times heavier than hydrogen, then there is 16 times the mass of matter in oxygen that there is in hydrogen; and if gravity acts on mass, oxygen is attracted 16 times more forcibly by gravitation than hydrogen is. Therefore, the formula H_2O means that in a molecule of water one-eighth of the substance or mass is hydrogen.

If we conceive of an atom of oxygen at a sufficient distance from the earth that the earth's gravity-pull on it should be the same as its pull is on an atom of hydrogen at the earth's surface, and if it were possible to divide the atomic mass of oxygen in 16 parts, and one of those separated parts should vibrate with the same rate of motion as a hydrogen atom vibrates, how would it be possible to distinguish the particle of oxygen from a hydrogen atom? There would be no distinguishing characteristics, for they would be equal in weight, equal in velocity, equal in mass, and the spectrum colours would be similar.

Heat and light-giving powers are not functions of the molecule, but of the atom; for it is in the act of dissociating and becoming atomic that elements give up energy, when the molecules are broken up and the atoms form fresh combinations. Gases are bodies which have lost in a great measure the attractions which molecules have for one another. In compound gases, where each molecule consists of two or more atoms, the atomic attraction still remains; but in simple gases, absolutely and atomically dissociated, there is no attraction. The sun may be a globe of such gases of so high a temperature that they are atomically dissociated and there is no molecular and no atomic attraction. These atoms, when freed from the thraldom of cohesion, are then free to vibrate with intense but varying rapidity, and upon these varying degrees depends the frequency and the length of the waves they give off into space. The spectroscope proves that such atoms vibrating at different rates give rise to different colours, and manifest different properties and different effects. From the above considerations I conclude that a small number of elementary substances are capable, according to the rates of their atomic vibration and their

* M. D'Arsonval has shown that our nerves, which affect sensation as well as motion, are made for certain determined vibrations and respond to those and none other.

mass—that is, according to the temperature and the amount of matter contained in the atom—of manifesting all the phenomena, and all those actions on compounds, which are usually regarded as properties vested in a series of elements, and each of which is supposed to have a separate individuality and to be a distinct entity.

Of course, until a set of experiments can be devised and carried out, the above must remain a more or less probable hypothesis; but the tendency of modern chemical and physical research is to show that there is only one kind of matter, varying according to development and environment.

E. WOODHEAD.

Derby, May 29.

COMPOUND ENGINES.

To the Editor of THE MECHANICAL WORLD.

SIR,—Your correspondent "Mechanical and Constructive Engineer," writing on the above subject in your issue for May 19, seems to have had a very remarkable experience indeed—so remarkable, in fact, that it would be very interesting, not to say instructive, if he would favour some of his more unfortunate fellow-engineers with more definite information on the subject. In the first place, he thinks that a cylinder proportion of 4 to 1 is very unusual, and he advocates a proportion of 3 to 1. I differ with him on this point; for my experience—which perhaps is not so long and varied as "Mechanical and Constructive Engineer's"—leads me to give the following ratio of cylinders, as found in actual practice, both in stationary and marine engines; I will not say for locomotives, as they are not under notice at the present. Commencing with from 70 to 80lb. pressure per square inch, a ratio is often used of about 3·5 to 1; then from 90 to 100lb., about 4; and from 100 to 120lb., about 4 to 4·5. Now, the engines under notice worked at 110lb. per square inch, so that they are quite within reasonable ratio, according to my experience.

It would be very interesting to have a fuller explanation as to how he expects to get the 800I.H.P. out of the two 9in. and two 15in. cylinders that he proposes to use. His system of keeping the steam on the whole length of the stroke suggests a very extravagant engine in the matter of coal bills. One would almost come to the conclusion that he has some coal mines that he is very desirous of getting into full work.

Referring to the letter in the "Engineer," June 6, 1893, I don't see how the system can be economically applied to loco. or marine practice, especially the latter. There would be a great waste of steam with the long steam ports necessary with such an arrangement.

I should not think your correspondent has had much experience with marine engines, unless for fresh-water river service; it seems so ridiculous to advocate dispensing with the air pump and surface condenser in order to exhaust into the atmosphere. And where does he expect to obtain the feed water from, without choking the boilers with salt?

I trust that your correspondent will favour us with further information on this new departure in engineering.

Hyde, May 29. J. W. H.

SCREW-CUTTING LATHES.

To the Editor of THE MECHANICAL WORLD.

SIR,—In your issue for June 2, "Screw Jack" asks for reasons why a lathe will produce square-threaded screws having threads of unequal thickness. As a turner with some experience of screw-cutting, I may say that, in my opinion, the cause of this is to be found in the lathe, as will be seen from the following considerations:—In "ordinary" screw-cutting lathes the collar on guide screw receives the thrust when cutting right-handed threads, and this collar being quite true on the face is the principal reason why the right-handed threads are equal in thickness. This is so whether the face of bearing on lathe bed is true or not. And this would account for "Screw Jack's" right-handed threads all measuring the same. But in cutting left-hand the opposite end of guide screw receives the thrust in drawing carriage along, and if the friction washers, lock nuts, and the face of the bearing are not true, an oscillatory movement of the guide screw is caused which will result in thick and thin threads being cut on any screw which is finer or coarser in pitch than the guide screw. I might point out other causes, but I think that the above-mentioned is the principal one, and if "Screw Jack" will see to this I believe he will find it possible to cut true threads either R.H. or L.H. on an "ordinary lathe." H. G.

Manchester, June 4.

LOW AND BEVIS'S "MACHINE DESIGN."

To the Editor of THE MECHANICAL WORLD.

SIR,—In the review of "A Manual of Machine Drawing and Design" which appeared in your issue of the 26th May, I notice the misleading statement that "in the concluding section of the work are given complete working drawings of the engines of the 'City of Paris.'" As a matter of fact, if your reviewer will examine the work more carefully he will find that no drawings whatever are given of that famous liner's engines, the only space devoted to the consideration of her machinery being not more than half-a-page of descriptive matter. The drawings actually given are those of a very small set of engines of about 150H.P., whose crankshaft is only 4in. diameter, whilst that of the "Paris" is over 20in. The error has probably arisen from the absence of any titles on the drawings, and the fact that they immediately follow the brief description of the liner's engines above referred to. W. H. ATHERTON.

Newcastle-on-Tyne, June 1.

Miscellaneous Items.

The death is announced of Mr. A. W. Meston, the inventor of the "Meston" motor.

A new telegraphic cable is being laid to the Mauritius, and it is expected to be put in operation by July next.

Mr. Sidney H. Wells, Wh. Sc., Assoc. M. Inst. C.E., Assoc. M. Inst. M.E., of the Yorkshire College, Leeds, has been appointed Principal of the Battersea Polytechnic Institute.

A large number of men are now engaged on the repairs of the battleship "Howe," and it is expected that she will, if the tide permits, be able to leave the dock about the middle of this month.

Orders have been given at the Washington ordnance shops to construct an 8in. gun, 50 calibre, of steel. It will be what is known as the Hurst gun, of the built-up type and hooped, and will be chambered to load with high explosives.

A new system of paving, known as "Ellis's," has been experimentally laid in Bridewell-street, Bristol. It consists of branches of oak of equal length set vertically and driven as pegs into a layer of sand and ballast, the interstices between the pegs being filled with grit. It is asserted that the pegs cost less than the ordinary pine blocks and have great weight-bearing power.

The Prussian State Railways recently made a test of speed between Grunewald, near Berlin, and Schneidemühl, a distance of 216 miles. The train was composed of seven six-wheeled and two four-wheeled carriages, and was drawn by an express locomotive of the latest type. The speed attained, exclusive of stoppages, was 55·2 miles per hour, which is the highest yet attained on German railways.

It is expected that the Corinth Canal will be opened in about a month. The works were begun in May, 1882. The new waterway will be 6500 metres long, 22 metres wide, and 8 metres deep. The width and depth are thus the same as in the Suez Canal. It will make a perceptible difference in the distance between the ports of Western Europe and those of Greece, Turkey, and the Black Sea.

The members of the Manchester Association of Engineering Students visited the Rochdale-road Gasworks on Saturday, the 3rd inst. Under the guidance of Mr. Leigh, the undermanager, the various processes of gas manufacture were inspected, and an interesting visit was brought to a conclusion by an examination of the water-governors and indicators which regulate the pressure of the gas in the mains.

The new corridor train which has been built by the Great Western Railway Company for service between London and Penzance arrived at Paddington on the 30th ult., from the Swindon Works, where it has been constructed. It is composed of four vehicles, a first and third composite, a brake second-class, and a brake third-class, and a third-class carriage, each 56ft. long, the entire length of the train being just 224ft. The carriages have comfortable smoking saloons, and are connected by flexible leather gangways.

The British Minister at Bogota, in his last report, says that the celebrated emerald mines of Muzo are situated about eighty miles to the north and north-west of Bogotá, on the bank of the river Minero. They are Government property, but are farmed out to a Colombian-French syndicate at a yearly rental of £2250. The working expenses can be roughly estimated at £10,000 per annum, and the mines yield a fair profit, the production of emeralds being of the value of about £20,000 annually. The rough stones are mostly sent to Paris to be cut, as native work is inferior to foreign. These mines are situated in a very rough, wild country, with nearly impassable roads. At the present moment there are about 300 natives employed at the works. The mode of working is by open cuts, the débris being washed down the river by water collected in a reservoir built above the level of the mine.

Queries.

Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

TURNING CHILLED ROLLS.—Can any reader oblige me with any information on this subject?—T. A.

WOOD'S AUTOMATIC PRESSURE RELIEF VALVE.—Required the address of the makers of this valve.—BELL AND CO.

OIL MERCHANTS.—Will any reader give me the London address of the Cleveland Lubricating Oil Company, U.S.A.?—A.H.

RAILWAY CROSSINGS.—Given the ratio of angle of intersection, say 1 in 8, what is the simplest method to convert into degrees of the quadrant?—L. V.

CHURCHILL SLIDE VALVE.—Can any correspondent inform me who are the makers of the "Churchill Patent Slide Vale"? Any information would be thankfully received.—J. M.

GUTTA-PERCHA.—Can anyone tell me of a process for melting either raw or manufactured gutta-percha, and how, after moulding, to cause the gutta to set firm and solid?—J. C. W.

RETEMPERING EDGE TOOLS.—Will any reader inform me if there is any method of tempering pattern makers' chisels and gouges that have been burnt in a pattern-shop?—CYMRO.

CLEANING BOILER TUBES.—Will some reader describe a useful tool to remove hard, thick scale from cross tubes in a vertical boiler? Tubes 9in. diameter and 4ft. 6in. long.—NOVICE.

WARSOP AERO STEAM ENGINE.—Any information about the working of the above engine, tried about 1870, such as the effect on the boiler, cylinder, piston rod, etc., will oblige—M. R.

GALVANISING.—Can any reader inform me whether it is possible to do galvanising on a small scale, say 3 or 4cwt. spelter bath; also the process of preparing cast-iron work for the bath?—T. J.

CASE-HARDENING FURNACE.—Will any practical reader give a sketch of a good furnace for case-hardening purposes, cutter-heating, etc., gas, liquid fuel, or coke, or the name of any maker of such?—LISTER AND CO., Keighley.

EMERY TAPE MACHINES.—I have an emery tape machine that I have a lot of trouble with through the tapes breaking continually. Can any reader who has a similar machine recommend a good tape?—CHEVIOT.

STEAM REVERSING GEAR.—I should be much obliged if any reader will explain the working of a steam reversing gear for locomotives, which I have seen on the following railway companies' engines:—Glasgow and South-Western, Mersey Tunnel, and South-Eastern. A sketch would assist me.—F. TURTON.

THEORETICAL DIAGRAMS.—Will any reader sketch and describe the theoretical indicator diagrams which would be obtained from a set of triple-expansion engines, having given—Load on safety valves, 150lb.; height of barometer, 30in.; ratio of cylinder volumes, 1, 2½, 5; total ratio of expansion, 8?—HYPER.

STAKING ON WHEELS, ETC.—Will any reader inform me of the best method of staking wheels or pulleys on shafts, say, with four or six keys? Should they be set true opposite the staking wedge, or opposite the permanent keys? Some information on this subject, or a sketch of same, would greatly oblige—STAKING WEDGE.

FEED PUMPS.—In working out feed pumps for common high-pressure engines, Molesworth says, p. 493:—"Take cubic contents of cylinder and one steam passage and multiply by 4, and divide by proper specific volume for given pressure." Why multiply by 4? There are only two cylindersful of steam discharged to one revolution or one stroke of the pump. Then, again, should not the cubic contents of cylinder be taken to cut off only? For instance, if steam is cut off, say, at half-stroke, and initial pressure be 100lb., the specific volume for which is 270, we find a great difference from the plan of taking the full cylinder at the average pressure, which at 100lb. initial pressure will be 75 average, the specific volume for 75 being 353, not to mention the difference in the two cubic capacities. Feed pumps worked out according to Molesworth's rule and others always come out much too large—nearly three times. I shall be glad if some reader will explain this.—COLD WATER.

Replies.

Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

JUDGE.—We do not reply to anonymous writers.

AN INDIAN.—We are obliged for your letter, but it is scarcely suitable for our columns.

K.—Greenwood's "Steel and Iron" (5s.) will probably suit you. It may be had from our office.

YOUNG ENGINEER.—Your idea is not new. The difficulty is in keeping a steam-tight joint. We believe that something of the kind has been tried and abandoned.

POLISHER.—We would advise you to procure a copy of Graham's "Brass Founder's Manual," which contains information on polishing, chasing, burnishing, etc.

J. C. N.—Taking the ultimate strength of your steel at 100,000lb. per square inch, we have

$$W = \frac{0\cdot196 \times 100.000 \times (1\cdot25)^3}{3} = 12,740\text{lb.}$$

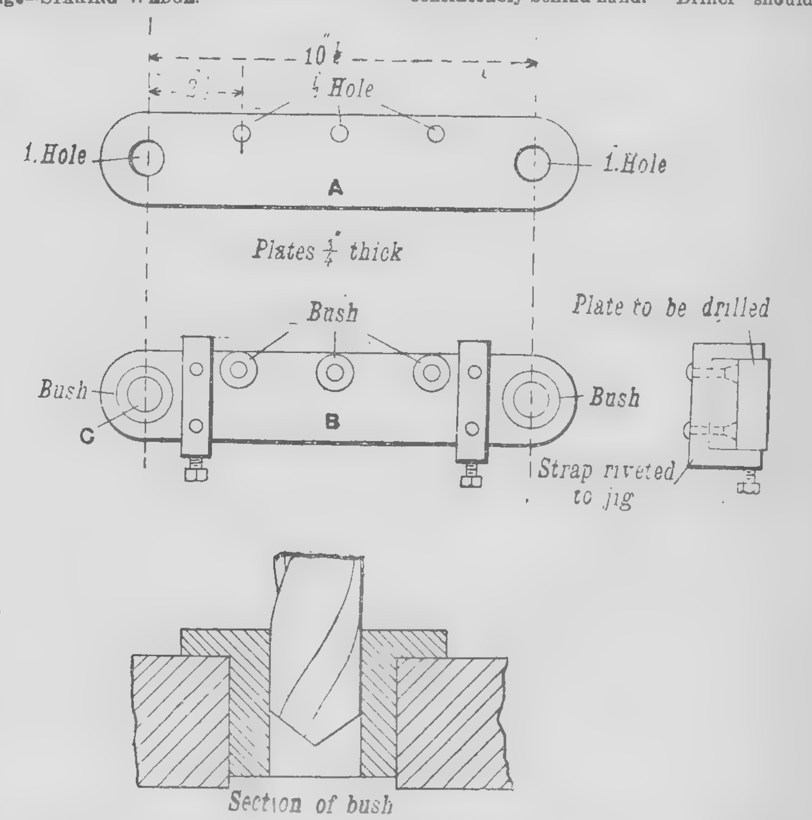
The shearing stress with this load will only be about 31,000lb. per square inch.

BEAMS.—The ultimate strength in lb. of the first beam may be obtained by the following rule:—Multiply the depth of the beam in inches by 536¼ (for red pine) and by the cross-sectional area of the beam in inches; then divide the product by the distance between the supports in inches. In your case

$$\frac{536\frac{1}{4} \times 9 \times 54}{192} = 13,577\text{lb.}$$

is the ultimate strength, but only about one-fourth of this should be applied in practice as a permanent load. In the second case about 23,000lb. could be supported.

JIGS FOR DRILLING.—The Americans often use what is termed a jig for drilling. Will anyone kindly give a sketch, together with drill?—DRILLER.—*A.*—The jigs referred to are not exclusively American, nor are they even of American origin. I have used them for some years in England, and have seen them older than the present generation. They are even in use in the South of Ireland, notwithstanding the fact that engineering shops there are considerably behind-hand. "Driller" should



KEYS, COTTERS, ETC.—Can anyone inform me what kind of steel is used for making keys and cotter pins as used on most engines? The keys that are bought seem to be of better quality than the so-called mild steel as sold at very little more than the price of fair merchant iron.—STEEL.

CONDENSING COIL.—In constructing a condensing worm and tank, what amount of coils are necessary so that the distilled water may be quite cold, and what would be the quantity of water in tank to obtain the result? How can I arrive at the final temperature of water originally cold which has passed through 500ft. run of 1½in. pipe, the pipes being immersed in a tank containing water at a temperature of 200° F.?—CALOR.

first of all make a sort of case or cradle that any of his castings or forgings will drop into nicely, and they must be fixed tightly by wedges or set screws. At the required centres he should have holes about ⅛in. larger than the holes he wishes to drill. Into these holes he must fit turned collars or bushes of hardened steel. An ordinary twist drill will do the rest. The bushes must be a nice fit, but not so tight as to stick when the drill sets up heat. Herewith is a sketch of a jig I am at present using for a quantity of plates which are required to have holes in, as shown in sketch A. In practice I do not use a separate bush for each hole, but only one bush for *each size*, and drop them into place as the holes are drilled. Taking example given, the *modus operandi*

is as follows:—An undrilled plate is laid on the table of the machine, and the clips (which are riveted to jig plate) dropped over it. The set screws are then tightened, and, say, hole C is drilled. A piece of 1in. rod is then dropped in to prevent any chance of slipping, and hole D drilled, the bush being moved at each operation. One bush also will do for each small hole, simply taking it out of one seat and dropping it into another. If "Driller" will send me his particular requirements, I will see what I can do for him.—WILLIAM F. RICHMOND.

DYNAMO WINDING.—Can any reader oblige me with the proper winding for an E.P.S. type dynamo of the following dimensions (in centimetres), so as to obtain at least 4 volts 3 ampères at a speed of about 2000 revolutions per minute:—Length of magnet bar, 11; length of yoke piece, 8·4; width of magnet and yoke piece, 5·3 each; depth of yoke piece, 2·5; thickness of magnet bar inside bobbin, 3; diameter of armature, 5; length, 5·3; air gap, ½ millimetre all round? It has a laminated armature, with 12 interruptions $\frac{3}{16}$in. wide by ¼in. deep, and a corresponding number of sections in the commutator. The magnets are of Swedish cast iron. I have tried it with 2000 turns of No. 38 B.W.G. on the field and 120 turns of No. 26 B.W.G. on armature, but can get hardly any current.—E. P. S TYPE. ——*A.*—Mr. J. Nealor Cooper, 12, Westbourne-street, Walsall, will give you the required information upon hearing from you.

METALLURGICAL FURNACE.—Can any reader furnish me with a scheme for supplying the heating power necessary for a metallurgical laboratory situated in iron-ore mining district, and where no gas is available? A small muffle furnace would be required, in addition to the ordinary heating power, and the fuel used is charcoal. Accommodation only required for one chemist.—H. S.——*A.*—Messrs. Charles Carr, Bell Foundry, Smethwick, Birmingham, supply such furnaces as you require.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

23rd May, 1893.

10,150 METALLIC DRIVING ROPE. J Howard.
10,157 TIDAL RECKONING or CALCULATING APPARATUS. W Absolom.
10,164 MACHINES for PLANING METAL. C R Jones and G Richards and Co. Limited.
10,167 HEAT ENGINE or THERMIC MOTOR.* J Y Johnson. (*E Gobbe, Belgium.*)
10,173 HYDRAULIC LIFTS. J A Steven.
10,181 FLEXIBLE METALLIC SHAFTING. P Ashberry and W Barnes.
10,175 DIRECT-ACTING STEAM ENGINES with EQUILIBRIUM SLIDE VALVE for the PROPULSION of STEAMSHIPS WITHOUT the AID of PADDLES, SCREW PROPELLERS, PROPELLER SHAFTS, ETC. W Hutchinson.
10,183 ASTRONOMICAL INSTRUMENTS. J B Murray.
10,190 APPARATUS for PRODUCING an ATMOSPHERIC or BUNSEN SMOKELESS FLAME from LIQUID HYDROCARBONS as FUEL.* J Lee and S Lancaster.
10,195 STAVE-JOINTING MACHINES.* J Anthon.
10,196 PHOTOTYPE MACHINES.* A J Boult. (*A P Stanford, United States.*)
10,199 CAR COUPLERS.* L N Singin.
10,204 MACHINES for CUTTING CYCLOIDAL SURFACES.* J T Wilkin.
10,205 ELECTRIC STEERING GEAR.* F L and L H Dyer.
10,207 ELECTRODES for ARC LAMPS.* A C Seibold.
10,209 CHUCKS for HOLDING TOOLS in BORING and TAPPING MACHINES. J M Kelly. *A A Fisher and W G Nelson, United States.*)
10,212 BOILER FURNACES.* F Steffens.
10,215 MANUFACTURE of IRON and STEEL and COMPOUNDS or PREPARATIONS to be USED THEREIN.* J A Hunter.
10,216 COOLING APPARATUS for FLUIDS. T Ledward.
10,218 REGULATING the DISTRIBUTION of ELECTRICITY and in CONVERTING ITS ENERGY INTO THAT of LIGHT. R Wood.
10,223 GAS-PRESSURE REGULATORS.* A J Boult. (*F Stahlschmidt, Germany.*)
10,227 CARBURETORS.* C R Collins.
10,228 MACHINES for TWISTING RODS or BARS.* G H Sellers.
10,239 NON-CONDUCTING COVERINGS for BOILERS, STEAM, HOT-AIR, and HOT-WATER PIPES.* J C Fell. (*H C Goodell and W E Richards, United States.*)
10,240 STEAM and OTHER ENGINES and PUMPS. E Gessner.

24th May, 1893.

10,242 TELEPHONIC APPARATUS. C Adams-Randall.
10,245 SLIDE VALVES. J Menzies and R Rogerson.
10,251 COMBINATION of ROLLER and BEARINGS. E Williams and J Chapman.
10,256 FEATHERING and ADJUSTING the PITCH of SCREW PROPELLERS.* H McIntyre.
10,260 HEATING by the HOT WATER of CONDENSATION. H H Strongitharm.
10,274 VALVE GEAR for GAS and PETROLEUM MOTOR ENGINES.* C D Abel. (*The Gas Motoren Fabrik Deutz, Germany.*)
10,275 CAR WHEELS.* J A Webber.
10,279 CAR COUPLERS.* A J Boult. (*R K Dorsey, Canada.*)
10,282 DOVETAILING MACHINES.* A J Boult. (*H Farchmin, Germany.*)
10,283 ELECTRODE PLATES for SECONDARY BATTERIES.* J E Hofmann.
10,285 SAFETY DEVICES for ELEVATORS. W P Kidder.
10,286 DEVICES for SUPPLYING AIR to FURNACES. W P Thompson. (*A Decker, Germany.*)
10,292 COMBINED ELEVATOR and CARRIER. C M Bates and H C Lutz.
10,294 BRAKE-SHOES. M Y Baldwin.
10,298 DYNAMO-ELECTRIC MACHINES. W B Sayers.
10,299 COCKS or TAPS. F B Rawes.
10,304 LIGHTING and EXTINGUISHING ELECTRIC LAMPS for STREET LIGHTING. J Lobley.
10,305 SPEED or REVOLUTION INDICATORS. C Brunner.
10,310 GAS and LIKE ENGINES. J W Hartley and J Kerr.

25th May, 1893.

10,336 MICROPHONIC CONTACTS. G L Anders and W Kötgen.
10,347 BATTERY SWITCHES.* H K Spangenberg.
10,359 AERIAL MACHINES. H F Phillips.

26th May, 1893.

10,361 AUTOMATIC SAW-SHARPENING MACHINE. R H and J F Shaw.
10,363 ELECTRICALLY-CONTROLLED ARC LAMPS. F T Schmidt.
10,365 VALVES USED in CONNECTION with HYDRAULIC and OTHER PRESSURE MACHINES. E Dearden.
10,367 PROCESS of LEAVING MALLEABLE or SOFT PORTIONS of STEEL ARTICLES in HARDENING and TEMPERING. O G Goodman.
10,382 SWITCH for ELECTRIC APPLIANCE. T E Carmichael.
10,383 FEED HEATERS for BOILERS of the MARINE or OTHER SUITABLE TYPE. A E Allen.
10,388 VALVE GEAR of STEAM ENGINES.* W P Thompson. (*T Delville, Belgium.*)
10,389 IMPROVED MANUFACTURE of GAS RETORTS, ETC. H Evers-Swindell.
10,390 FIRE ALARMS. L J Tirard.
10,391 PIPE WRENCHES.* W Craige.
10,395 STEELYARD WEIGHING MACHINES. C Woollett and H Howlett.
10,396 ELECTRIC CONDUCTORS. W L Dudgeon. (*La Société Anonyme J Cockerill, Belgium.*)
10,398 EFFECTING ELECTRICAL COMMUNICATION with VESSELS or BUOYS at SEA. G C L Lenox.
10,399 HOLDER for the PLATES of ACTIVE MATERIAL USED in SECONDARY BATTERIES. D G Fitz-Gerald and others.

27th May, 1893.

10,409 COMPOUND LOCOMOTIVES. B Malcolm.
10,411 STOP VALVES. J A and J Hopkinson.
10,415 ANCHOR. W Green.
10,416 CIRCULATING BOILERS. T Wood.
10,417 CIRCULATING BOILERS. T Wood.
10,421 APPARATUS for RECORDING the LEVEL of WATER and OTHER LIQUIDS. The Palatine Engineering Company Limited and R Blakiston.
10,425 SCREW GRIPS for ROPE HAULAGE. W S Parkes.
10,427 PRESSURE and VACUUM GAUGES. T E Mitton.
10,430 REDUCING VALVES. W G Wrench.
10,431 CENTRIFUGAL MACHINES for DRYING and SEPARATING FURNACES. S Barrett.
10,438 APPARATUS for RESTRAINING and GOVERNING PROPELLER ENGINES. J Yorke.
10,439 GAS ENGINES. J A McMullen.
10,441 CONDUIT ELECTRIC RAILWAY. E T Hughes. (*W R de Voe, United States.*)
10,444 FOG-SIGNALLING APPARATUS. R M Richardson.
10,446 MANUFACTURE of ARTIFICIAL FUEL BLOCKS and BRIQUETTES. S W Dew.
10,452 INSULATION of ELECTRIC CONDUCTORS. D Cook.
10,455 SENSITIVE DRILLING MACHINE with COMBINED HAND and TREADLE FEED.* A Clark.
10,454 REGULATING DEVICE for INCANDESCENT GAS LAMPS. P W de Beaux.
10,456 MACHINERY for MAKING and PRESSING BRICKS. W Wilkinson and H Alexander.
10,458 TREATMENT of SEWAGE or ANALOGOUS FOUL WATERS or MATTERS for EFFECTING PURIFICATION THEREOF. A P Hope.
10,462 APPARATUS for STOPPING and STARTING MACHINERY. S Ford.
10,463 PICKLING IRON and STEEL PLATES PREVIOUS to TINNING or GALVANISING. H J Kirkman.
10,467 APPARATUS for EVAPORATING LIQUIDS by MEANS of STEAM. E Latham and E G Guyot.
10,468 STEAM-ENGINE GOVERNORS. W Sisson.
10,469 FACILITATING the STARTING of LIQUID HYDROCARBON ENGINES. W D and S Priestman.
10,470 CENTRIFUGAL MACHINE ADAPTED for USE as a PUMP BLOWER or EXHAUSTER. J A Wade and J Cherry.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to SIR H. READER LACK, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

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EVERY FRIDAY. ONE PENNY.

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FRIDAY, JUNE 16TH, 1893.

Our Machinery Exhibits at Chicago.

BRITISH ENGINEERS, and indeed all connected with the manufacturing trades, will hear with regret that the attempt of Great Britain to show her American cousins at Chicago some specimens of her wonderful skill in the mechanical arts is a signal failure. No country has apparently shown less interest in making a creditable display in this line than our own. Many British exhibitors, owing to one cause and another, have dropped out at the very last moment, the result being wide open spaces, with exhibits scattered here and there, thus giving to the British section an air of emptiness. Visitors must wonder what has become of the long list of exhibits from Great Britain, as there are nearly two pages in the guide taken up with the names of our firms who intended exhibiting. The German exhibit is indeed a great contrast, and a foreigner passing from the one to the other could not fail to be struck with the finish and style of the Continental exhibit as compared with ours. There are, of course, a few exhibits of merit in our section, but while one or two have attracted a good deal of attention, very severe criticism has been passed on others. The Galloway engine, which stands by itself at one end of the machinery hall, had the misfortune to run hot shortly after starting up; but this was due in part to the use of inferior oil. It is now running again, although only at quarter speed, as there is so much water in the steam pipes The somewhat novel design and appearance of this engine have attracted the attention of many engineers. But the exhibit which has created as much or more interest than almost any other in this department, is that of Messrs. Willans and Robinson's high-speed central-valve engines, of which only one has as yet been erected. When completed, they will develop over 1000H.P., some of the power being used for driving a section of shafting, and the rest for driving a Siemens dynamo to supply the search-lights on the manufacturers' building. This engine is a novelty to the majority of American engineers, but as Messrs. Willans and Robinson have negotiated with a Chicago firm for the manufacture and sale of their engine in America, it will no doubt become as popular as it is in our own country. There is a prevalent opinion among a good many who have had opportunity and leisure to study the exhibits in the machinery hall that, taken as a whole, they form rather a disappointing show. But there are many redeeming points which, as soon as things become more settled, will help to remove this feeling from the minds of engineers and others who might otherwise be inclined to offer derogatory criticisms thereon.

Heating Boilers with Refuse.

WHEN it is borne in mind that the St. Pancras Vestry supplies the electric light at a low charge, it is not surprising that within the short period of eighteen months no less than 11,000 lamps have been connected to the distributing mains, the maximum station capacity being equivalent to 13,300 lamps installed, or 10,000 simultaneously alight. It is thought that the demand will increase beyond the difference between the two—namely, 2300 lamps—during the next year and a half, and in this connection a proposal has been made to erect a second station, to be worked with greater economy by the use of refuse destructors. Two committees of the Vestry have just issued a joint report on this matter, dealing with the proposed combination in one system of the collection of house and street refuse, the burning of such refuse, and the utilisation of the heat obtained from such burning for the generation of electricity. The principle of the destruction of the refuse by destructors is now well recognised, and is being carried into effect by various local authorities in the kingdom. Dust-destructor works are to be built on land belonging to the Vestry, and it is suggested that a second electric-light station should be combined with those works. The heat from the destructors would be utilised in the boilers and for other purposes. The scheme provides for plant to serve 4800 lamps installed, and capable of extensions being carried out at any future time. As a commencement, three engines of 200H.P. each and three boilers would be laid down; the boilers would be heated by the gases from the destructors passing round the outer shell and escaping by the main flue, crossing under the front end of the boilers to the chimney. The power available from the destructors will not be less than 300H.P. with the first instalment of three boilers, and 500H.P. with a complete set of five boilers. Arrangements are also provided for firing these boilers with coal in the usual manner by hand, or by mechanical stokers, so that steam may be more rapidly raised to meet any sudden demand due to fogs, and at times of maximum load. The engineers to the Vestry recommend the adoption of this combined system, which, in the case of lighting, would, it is estimated, yield a remunerative return. If the scheme is carried into effect it will be the first attempt on a practical scale to utilise house and town refuse in the production of electricity for illuminating purposes, and, as such, it should tend to solve the problem of dealing with such refuse in a manner calculated to give good commercial results, whereas the present method of disposing of it is expensive.

Tempering Steel Wire.

SOME improvements in the method of tempering steel wire have recently been made by an American firm of spring manufacturers, by which it is claimed many of the difficulties usually attending this process are overcome. The apparatus consists of a vertically-arranged tube of such material as to be readily heated to the desired temperature by the passage of an electric current through it. The upper end of the tube is closed by a centrally-perforated cap through which passes the wire to be tempered. The lower end of the tube enters the cooling bath. The tank holding the oil is so arranged that the oil flows upward at a constant speed. It is claimed that no air comes in contact with the heated part of the wire, and that there is no oxidation possible. The heated wire passes vertically into the oil without contact with any packing substance or any material to reduce its temperature. By the flow of the chilling fluid a perfectly even temperature of the fluid is maintained at the point where the heated wire comes in contact with it. The flow of the oil parallel with the wire prevents the formation of gas bubbles upon the surface of the spring, which would prevent the even chilling of the metal, and would thereby cause the wire to buckle. By the use of electricity the inner tube of the muffle can, it is said, be kept at an even heat and under easy control.

Lighting in Westminster.

AT the recent meeting in the metropolis of the members of the Federated Institution of Mining Engineers, visits were paid, among others, to the electric-light stations of the Westminster Electric Supply Corporation. There are three stations having a total capacity of 186,000 incandescent lamps of 8C P., of which 109,000 are at present connected to the mains. The system in use is the low-tension direct-current distribution, with a third wire connected to a battery, which not only aids the regulation, but also supplies current at night when the engines are stopped. The dynamos are wound to give current at 220 volts, and their terminals are connected across the outer mains. The distribution to the various parts of the network is effected by means of feeder mains at a pressure of 102 volts, and at 100 volts in the distributing mains. All three stations are connected to the general network of mains, so that in slack times it is possible to shut down two stations, leaving the other to take up the load. One of the stations furnishes current for the illumination of the Houses of Parliament, the others giving a general supply.

Heating Railway Carriages.

IT will be recollected that about twelve years ago considerable attention was given to a method of heating railway carriages by acetate of soda. The principle of the system, as is generally known, lies in the fact that acetate of soda, after having been brought to a state of fusion by the application of heat, will cool very slowly and crystallise, and during this crystallisation process will again give out the heat originally absorbed. In practice, however, difficulties were experienced owing to the imperfect manner in which crystallisation occurred. This defect was overcome by admitting air into the vessel by a small cock, while the fusion of the salt was conveniently effected by a copper coil in the vessel. Even with this arrangement, however, a comparatively long time—something like thirty or forty minutes—was required to fuse the salt, and this, together with the difficulty of procuring the steam supply, prevented an extensive adoption of the method. Some improvements have, however, lately been made by the chief engineer of the Great Northern Railway of France, which will, it is thought, cause the system to be more favourably regarded than heretofore. In this case a copper pipe coil about 26ft. long, and having ten return bends, is provided inside the soda receptacle. The two ends of the coil are arranged side by side, and the openings are plugged. Steam is forced through the coil by an injector. Inside the soda receptacle are metal partitions dividing it into five compartments, this arrangement being designed to facilitate transmission of the heat to the outside. The receptacles are made of tinned mild steel, hold about 200lb. of acetate of soda, and weigh altogether about 59½lb. Fusion of the salt is accomplished in them in from ten to eighteen minutes, steam at 1½ atmospheres pressure being used in the coil.

One Hundred Miles an Hour.

IT will be remembered that the towns of Brussels and Antwerp intend to each hold an international exhibition in 1895, each claiming the right to do so, and that partly in connection with them, and partly to afford a rapid means of transit between the two places, a scheme has been prepared for the construction of an electric railway to connect the two towns, which are separated from each other by about 25 miles. M. Flamache (of the Belgian State railways), who recently described the projected railway, stated that it would form almost a direct line between Brussels and Antwerp, leaving Malines three miles to the east. The curves would be insignificant, and there would be few places where the line would cross the ground level, the level to be avoided as much as possible so as to obviate the necessity for slowing down the trains, which are proposed to run about 110 miles an hour. According to MM. De Rudder and Van Bogaert, State railway engineers at Antwerp, the cost of constructing the projected railway would be £760,000, supplementary works increasing this amount to £920,000. Each train would consist of either one or two carriages, with seats arranged longitudinally. At present the scheme exists on paper only, and until the necessity for the proposed railway is shown, the question of obtaining a concession for its construction will hardly be seriously considered, leaving the very high speed suggested out of consideration.

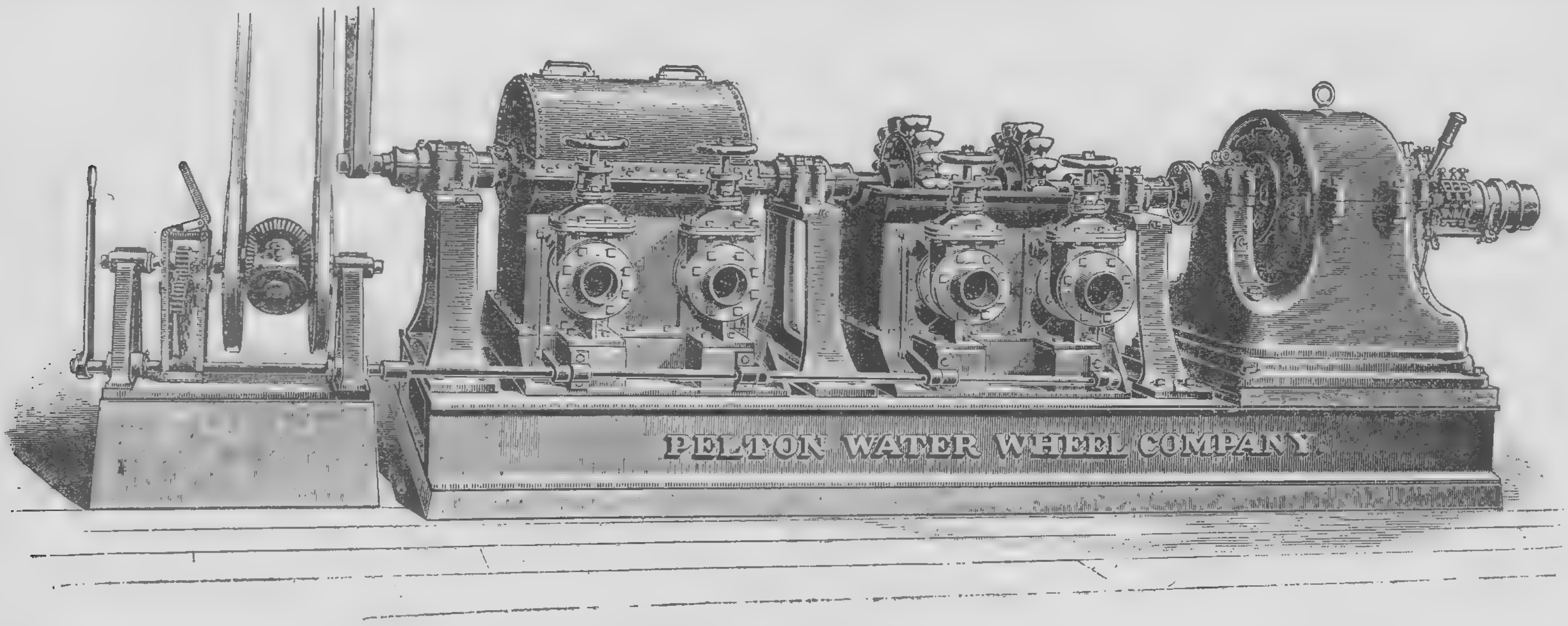
A New Welding Process.

BEFORE the Society for the Advancement of Industry at a recent meeting in Berlin, Dr. A. Slaby, of the Charlottenburg Technical High School, gave a demonstration of a new electric process for welding iron, devised by M. Julien, of Brussels. The lecturer took an iron bar, which formed one pole of a source of electricity, and plunged it into water containing the other pole. As soon as the bar entered the water, that portion of it immersed at once assumed a white heat, and Dr. Wedding made it into a rivet. This method is based upon the fact that if one pole of a source of electricity is plunged into acidulated water, or water having in it a salt solution, and a sufficiently strong electric current is passed through, oxygen is given off at the (lead) anode, and hydrogen at the (iron) cathode. By increasing the current the evolution of gas can be augmented to such a degree that the iron bar, surrounded by hydrogen, is no longer in contact with the solution. As, however, the hydrogen "envelope" offers great resistance to the passage of the current, considerable heating takes place, whereby the "envelope" and the iron bar are brought to a white heat or glowing condition. In this way temperatures up to 4000° F. can, it is said, be attained. Dr. Slaby states that no difficulties are experienced in regulating the temperature between 800 and 1200° necessary for the forging or welding of the iron, since the degree of heating depends upon the proportionate size of the anode to that of the cathode, as well as upon the available electric pressure. It is claimed that the Julien method is more advantageous than either the Benardos or Thomson electric-welding process, and that by its use iron bars of from 2 to 3 centimetres in diameter can be welded with current at a pressure of from 100 to 200 volts A large lead plate is suggested to be adopted as the anode, the cathode being practically formed by the appliance in which the iron bar is fixed for the time being.

250H.P. Electrical Generating Plant.

The illustration herewith represents an electrical plant recently constructed by the Pelton Water Wheel Company, of San Francisco, for generating power at one of the principal mines in the district, and is typical of a number of other designs for electrical plants made by the company this year.

The main drawing is so clear in respect to nearly all features that a description is not required; but the regulating mechanism, which is not completely shown, requires some explanation.



250H.P. Electrical Generating Plant.

On the small shaft, set at the left of the machinery, are two loosely-mounted pulleys, one driven from the main water-wheel shaft, and the other from a small, independent motor, or wheel without load, and having a constant resistance. These two pulleys are, says "Industry," driven in opposite directions, and connected by bevel wheels, as shown, the middle pair being attached to the shaft, so that when both pulleys are moving oppositely at the same velocity, the middle wheels and the shaft are still; but the slightest change in the relative velocity of the two pulleys at once turns the shaft on which they are mounted. On the end of this shaft is a pinion gearing into the toothed sector mounted on the motion rod seen in front, which is connected to wing valves in each of the wheel nozzles, governing the flow and speed accordingly.

This is called the differential method of regulating, whereby the position of the controlling valves depends directly on the relative speed of the two water wheels, or the relative position of the two pulleys. In other words, the main wheels must follow or conform in their speed to the independent motor, which is not subjected to any irregularity of resistance.

The novel feature in this regulating gearing has been the subject of a recent patent, and has proved very effective in several cases where it is now applied.

The wheels shown generate 250H.P. under a head of 340ft., the water being conducted through a pipe 3000ft. long. The dynamo is of the Westinghouse type—a twelve-pole alternating generator, to run at a speed of 860 revolutions per minute. The wheels are in this case made smaller in diameter than usual, and increased in number to meet the requirements of the dynamo in respect to speed, head, and power.

Sugar-making Machinery.

XXXIII.

Built-up Wheels.—Wheels of moderate size are generally cast whole. For convenience of transport they are sometimes made in halves, the number of teeth being such as to be divisible by 2, so that there may be an equal number in each segment. Such wheels are best made with H section arms, the division being made through the centre of two opposite arms, the parts being bolted together by strong bolts. Sometimes they are made to join together at the boss and rim, and held together by fitted bolts passing through prepared flanges at the rim and through raised bosses at the hub. Wheels of larger size are built up in segments corresponding to the number of arms; this permits of easy transport in countries where facilities for carrying such heavy machinery are not to be had; spare segments are also sent to replace breakage in working. The methods of building up such wheels are very various. Sometimes the boss and arms are cast in one piece and the rim in segments, or the boss and arms may be cast in two pieces and the rim in segments. In very large wheels the arms are cast separate and fitted into the boss, and attached to the rim segments by bolts or wedges.

The connection of the arms to the rim segments requires to be well made to ensure a true-running wheel.

Fig. 82 shows one method of construction. The arms are H-section, and bolted to the rim by four bolts having wedge-shaped heads let in between the teeth. The proportional units for the various parts are given on the figure for such wheels. These bolts for wheels 5in. pitch and upwards would be 2in. diameter, and for 4in. to 5in. pitch 1⅜in. diameter; 3in. to 4in. pitch 1¼in. bolts.

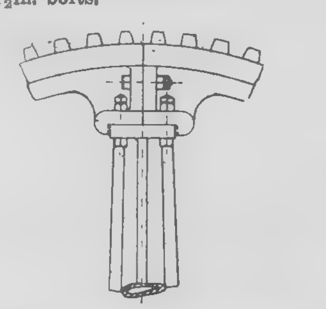


Fig. 89.

Fig. 89 illustrates a common method of construction. The arms are of hollow pipe section with radial ribs, on the end of which is a rectangular flange, machined to fit accurately to the ends of the segments as shown, four strong fitted bolts connecting the arm to the rim, and two additional bolts serving to connect the segments together endwise. The joggles on the rim segments take the shearing stress off the bolts.

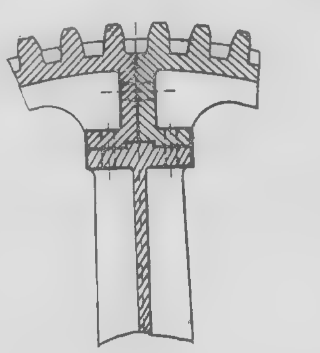


Fig. 90.

Fig. 90 shows a simpler, and, on the whole, a better arrangement. The end of the arm has a projecting dovetail let into the rim segments to take the shearing stress; the arms and segments being bolted together as before.

Fig. 91 shows another method of relieving the bolts of the shearing stress. It will be seen that a round key, generally of steel, is driven in at the junction of the parts. Some makers prefer to use a square key, but it is rather more expensive to fit than a round key.

Fig. 92 shows a different method of arranging the connecting flanges of the parts, and which will be readily understood from the sketch. We do not see that this method has any special advantages, and, if anything, must be more expensive to machine and put together.

Fig. 93 shows a method of joining the arm to the rim by means of wedges, and employed mostly by Continental makers. This is a favourite method in rolling-mill practice. The spaces between the joggles are filled up with dry oak and wedged up with iron wedges after the wheel is in place. It is open to the objection that when being erected on the plantation an accurate job may not be made in fixing it up. With the other arrangements there is not the same liability to improper fixing, as all the parts, being truly machined and marked, will come together accurately and without difficulty.

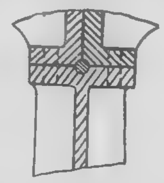


Fig. 91.

In large wheels, where the boss is cast separate from the arms and segments, the fitting of the arms into the boss admits of various treatment. Perhaps the most substantial way for very large and heavy wheels is to make the arms hollow section and fit their inner ends into a strong boss, as shown in Fig. 94, which shows a centre boss for a very large wheel having 10 pipe arms. The arms are 11in. diameter at the boss and 2in. metal, strengthened by four radial ribs 2in. thick. The arms are cottered into the boss by large wrought-iron cotters 6½in. broad by 1¼in. thick. Sometimes these cotters are made in halves, each half being put in from opposite sides. The arms, where they enter the boss, fit top and bottom, being 10in. diameter at the top part and 8in. diameter at the bottom. Sometimes the boss is turned on the edge and the ends of the arms provided with flanges faced to suit, and fixed by turned and fitted bolts, the edges of the flanges butting on each other all round.

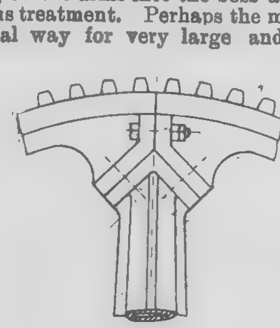


Fig. 92.

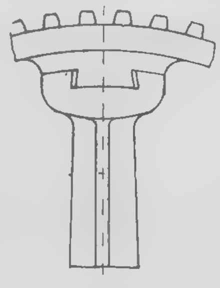


Fig. 93.

Fig. 95 shows a built-up second-motion wheel for a 36in. sugar mill, with the boss and arms constructed somewhat differently. The sketch shows the method of construction very clearly, and no lengthened description is required. The wheel is about 14ft. 7in. diameter, having 100 teeth, 5½in. pitch and 15in. face, built in 10 segments. The arms are solid, and fit into the side of the boss, and are bolted thereto by three 1¼in. bolts. The opposite ends of the arms are rectangular in shape, machined to fit in between the segments as shown, and bolted thereto by two 1⅞in. bolts, to the end of each segment, the heads of the bolts fitting in between the teeth. The wheel is hung on the shaft by four heavy keys.

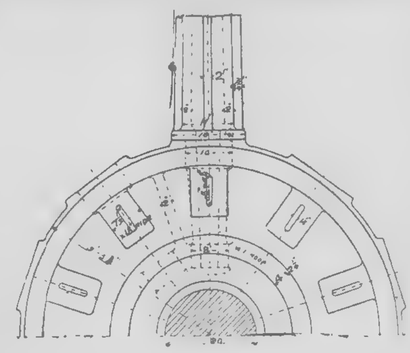


Fig. 94.

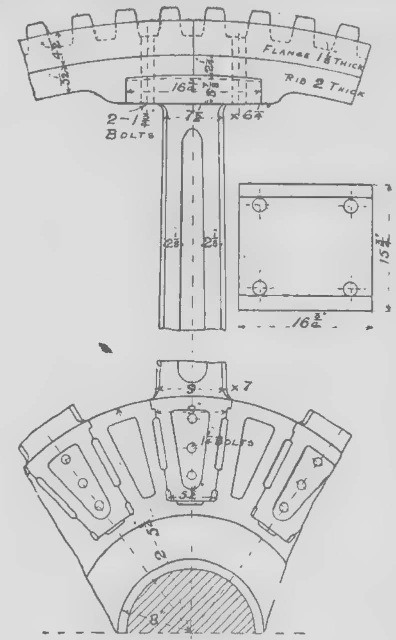


Fig. 95.

(To be continued.)

Acids in lubricating oils may be detected by putting the sample to be tested in a clear glass bottle, with a copper wire running down through the cork, air-tight. Stand the bottle in a sunny place, and leave for two or three weeks. If, on removal, verdigris or green rust is on the copper, there is an acid in the oil.

The Design and Construction of Stationary Engines.—LV.

Strength of Arms.—The arms should be strong enough to resist the whole stress that the shaft can safely transmit.

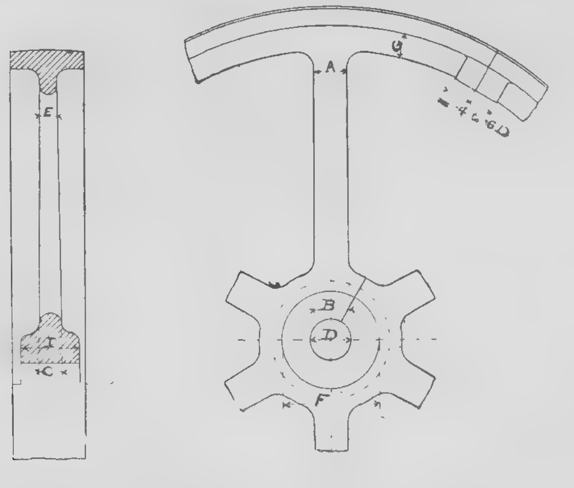
In calculating the size of the arms for such fly-wheels, it is assumed that each arm takes an equal share of the load, and is to be considered as a beam fixed at the boss end and free at the rim. This fact, together with the contraction stresses set up in casting, and the liability to shocks, necessitates the adoption of a high factor of safety.

For cast iron, 1600lb. per square inch may be allowed in such circumstances. Then if S = driving force transmitted by the ropes or belts in lb., D = diameter of wheel in inches, n = number of arms, the greatest bending moment (B.M.) on each arm is

$$\text{B.M.} = \tfrac{1}{2}\frac{\text{S} \times \text{D}}{n} \quad \ldots\ldots\ldots\ldots (7)$$

Let b = breadth of arm measured in direction of plane of rotation in inches, and t = thickness of arm in inches.

The proportion of thickness of arm to breadth should be greater than in ordinary belt pulleys. For elliptical section of arm of breadth b (measured at centre of wheel), thickness t may be taken at least $\frac{6}{10}$ of b.



Design, etc., of Stationary Engines.—Fig. 227.

The modulus of section for elliptical arm is $\frac{\pi}{32} \times b^2 \times 0{\cdot}6b = 0{\cdot}05892b^3$. Equating the bending moment of resistance

$$\tfrac{1}{2} \cdot \frac{\text{S} \times \text{D}}{n} = 0{\cdot}05892 f b^3 : f = 1600\text{lb.}$$

Then $b =$

$$\sqrt[3]{\frac{1}{0{\cdot}11784 f}} \cdot \frac{\text{S} \times \text{D}}{n} = 0{\cdot}1742 \sqrt[3]{\frac{\text{S} \times \text{D}}{n}} \ldots (8)$$

From this formula the following table (XXXIV.) of fly-wheels has been calculated (see Fig. 227):—

TABLE XXXIV.—FLY-WHEELS.

Cylr. Dia	Cylr. Stk	Diameter of Wheel.	Width of Rim.	A	B	C	D	E	F	G	H	I
in.	in.	in.	in.	in.	in	in	in	in	in.		in	in.
			6									
5	10	42	4½	2⅜	2¾	1⅝	2½	1½	5½	Approximately equal $\frac{8}{10}$ of A.	1½	3¾
6	12	48	5	2⅝	3	1⅞	3	1⅝	6½		1¾	4½
7	14	54	6	2¾	3¼	2	3¼	1¾	7		1⅞	5
8	16	60	7	3¼	3¾	2¼	3½	2	7½		2	5¼
9	18	66	8	3⅜	4	2½	3¾	2⅛	8		2¼	6
10	20	72	8	3½	4	2½	4	2⅛	8¾		2⅜	6
11	22	78	9	3⅝	4¼	2⅝	4½	2¼	9¾		2½	7
12	24	84	9½	3¾	4½	2¾	5	2⅜	10¾		2⅝	7½
				8 arms								
14	28	96	10	3¾	4½	2¾	5¼	2⅜	11½		2½	7½
15	30	108	10	3¾	4⅝	2⅞	5½	2⅝	12		2⅝	8
16	32	120	12	4	5	3	6	2½	13		2⅞	9
18	36	132	16	4¾	5¾	3½	7	2⅞	14½		3¼	10½
20	42	144	22	5¼	6½	4	8	3¼	15½		3½	12
22	42	168	24	5¾	7	4¼	9	3½	17		4	13½
24	48	180	26	6¼	7½	4½	9½	3¾	18		4¼	15

In this list of fly-wheels the crankshafts are supposed to be plain bars, and not swelled in the middle or turned down in the necks. The thickness of the rim obviously depends on the weight it is intended to have in the wheel.

When the fly-wheel is made in halves, it is joined at the rim with flanges and bolts, and at the boss also with bolts passing through strong lugs, in addition to which they are sometimes hooped with wrought-iron bands shrunk on, and indicated by the dotted lines in the figure.

Another formula for the strength of the arms has been proposed. Let D = diameter of wheel in feet, d = diameter of shaft in inches, l = effective length of arm in feet (measured from boss to outside of rim), n = number of arms, b = breadth of arm in inches measured in direction of plane of rotation, t = thickness of arm measured in direction of axis of shaft in inches; or minor axis of elliptical section.

If we assume the arm should be strong enough to resist the whole stress the shaft can safely transmit, and that the safe stress allowable for wrought iron is 8000lb., and for steel 11,000, and for cast-iron arms, as before, 1600lb. per square inch, we have for torsional moment of shaft

$$\text{M} = \frac{\pi}{16} d^3 \times 8000 \quad \ldots\ldots\ldots\ldots (9)$$

Moment of flexure of section of arm

$$= \frac{\pi}{32}\, b \times t^2 \times 1600 \quad \ldots\ldots\ldots\ldots (10)$$

And from (9) bending moment on one arm

$$= \tfrac{1}{2} \cdot \frac{1}{n} \cdot \frac{2l}{\text{D}} \cdot \frac{8000\,\pi\, d^3}{16} \ldots\ldots (11)$$

Now (10) and (11) must be equal, thus :—

$$bt^2 = \frac{10 l d^3}{n\text{D}} \quad \ldots\ldots\ldots\ldots (12)$$

Let $t = 0{\cdot}6b$, as before. Then

$$b^3 = \frac{16{\cdot}66 l d^3}{n.\text{D}} \text{ and } b = 2{\cdot}55 d \sqrt[3]{\frac{l}{n.\text{D}}} \;\ldots (13)$$

$$t = 1{\cdot}53 d \sqrt[3]{\frac{l}{n.\text{D}}} \quad \ldots\ldots\ldots\ldots (14)$$

These dimensions give a parallel arm; but they are usually made taper. Let B and T = breadth and thickness respectively of arm at centre, and b and t = breadth and thickness respectively of arm at rim. The ratio of strength of these sections should be about 1·75 to 1, from which is deduced from the above formula, for mean section the following :—

$$\text{B} = 2{\cdot}74 d \sqrt[3]{\frac{l}{n.\text{D}}} \quad \ldots\ldots\ldots (15)$$

and

$$\text{T} = 0{\cdot}6\ \text{B}. \quad \ldots\ldots\ldots\ldots (16)$$

$$b = 2{\cdot}26 d \sqrt[3]{\frac{l}{n.\text{D}}} \quad \ldots\ldots\ldots (17)$$

and

$$t = 0{\cdot}6\ b. \quad \ldots\ldots\ldots\ldots (18)$$

The section of fly-wheel arms is of various forms, generally I and elliptical forms for wheels of moderate dimensions.

Large spur and rope wheels have pipe or round hollow arms, or modified I shape, as will be seen on reference to the examples which will be given later.

Wheels over 16ft. in diameter are generally made in sections, having boss, arms, and rim separate; the methods of fastening these various parts are very numerous, as will be seen in the examples which follow.

(To be continued.)

Couplings.*

Compression couplings seem to be divided into two classes—one with conical collars, tapering wedges, or screws that act indirectly; and the other class, plain clamps that act directly by means of bolts or screws. If examined, however, it will be seen that in all couplings of either kind the method of compression is based upon flexure. There is, indeed, no means of reducing the bore of a coupling, or anything else made of iron, except by either flexure or condensation of the material.

This may seem a bold proposition in view of the fact that not only in couplings, but in many other cases, such as compensating bearings for shafts or spindles, we find devices for concentrically reducing the bore of holes; but if any or all of these contrivances are analysed, it will be found that no such reduction of bore can take place without flexure, and in the case of conical collars without the metal being condensed or "upset."

Another principle involved in all adjusting conical devices is that adjustment in the plane of the bearing or running faces can do no good—in other words, adjustment

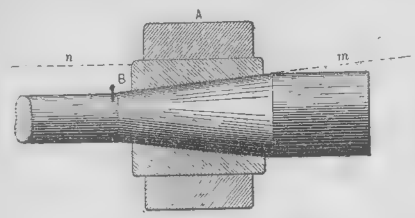
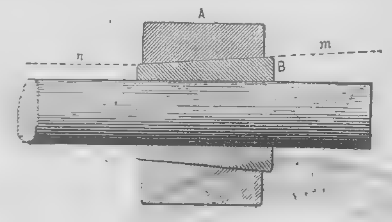


Fig. 1.



Couplings. Fig. 2.

parallel to any face causes no change normal to that face. It is true that many such adjustments are provided for clamping and for compensation in bearings, and seem to answer such a purpose; but this claim is only a compliment to good fitting, the fact being that adjustment is not required. This is certainly the case with the spindles of machine tools, because any attempt to adjust a conical bush diagonal to its exterior face must lead to distortion and a bad fit that would show itself in milling machines and lathes, where such bearings are usually found.

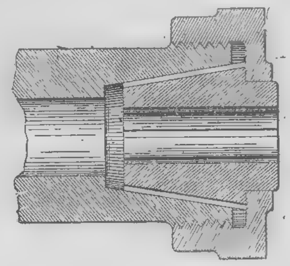
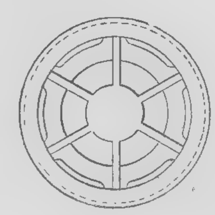


Fig. 3.



Couplings. Fig. 4.

In considering this subject of compressing or clamping devices by means of tapers or cones, it is important for those who have not previously examined the subject that this matter of adjustment should be made plain before referring to the particular devices. Figs. 1 and 2 are prepared for such explanation. Suppose that B and B are conical bushes, one tapered on the inside, as in Fig. 1, the other tapered on the outside, as in Fig. 2, and that the adjustment in Fig. 1 is on the line n, and in Fig. 2 on the line m.

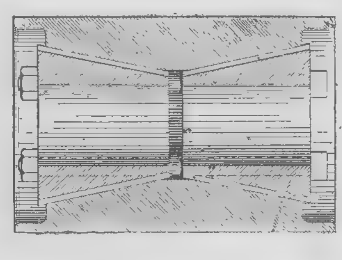
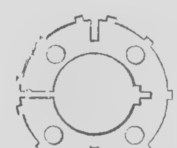


Fig 5.



Couplings. Fig. 6.

The construction in Fig. 1 is common in various kinds of machinery in Europe, and to some extent is employed in America for lathe spindles and the like. That in Fig. 2 is common in America, but, so far as is known, is not employed elsewhere.

The two things seem analogous at first sight, but they are not so. Adjustment in Fig. 1 is on the line n, diagonal to the running faces, consequently these approach or leave each other parallel as the bush B is moved backwards or forwards in the stationary part A, forming a complete annular adjustment.

In Fig. 2 adjustment is also on the line n, the same as before, but parallel to the shaft and the running faces, consequently it can have no effect on these faces without condensing or compressing the bush itself. It will also be seen that as this adjustment is diagonal to the outer faces of the bush on the line m, consequently it is not possible, because movement endwise cannot take place, unless, as before remarked, the bush is condensed.

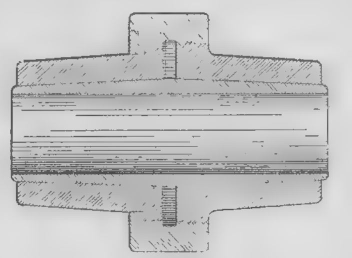
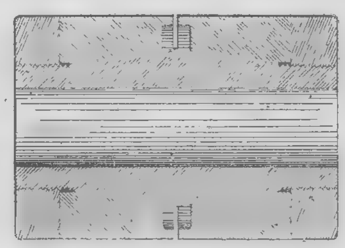
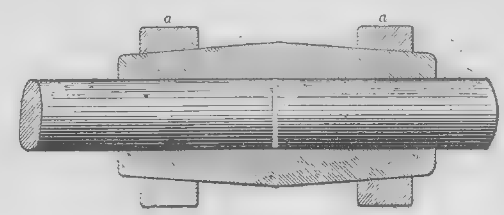


Fig. 7.



Couplings. Fig. 8.

If the bush is split it may be closed in a slight degree, but not concentrically, because there is no fit except in one position. It is bad construction in any case when directed to a reduction of bore, unless the bush is made of some soft alloy that can be compressed so as to change its shape. We have treated this matter at some length, because it is a method common in compression couplings, and its limitations are not well understood. It is not contended that there is no compensation or adjustment of such devices, but that it is infinitesimal without destroying the fit.



Couplings.—Fig. 9.

There is in some cases a successful application of this conical bush method of clamping, by cutting away the exterior of the cone so that it will bear on narrow faces only, as in Figs. 3 and 4, taken from a clamping spindle chuck made by a firm of machine-tool makers at Manchester.

Fig. 3 is a longitudinal section, and Fig. 4 an end view with the screw collar

* By J. Richards, in "Cassier's Magazine."

removed. The conical member is split into six parts, and the exterior cut away, so that the bearing is on twelve narrow ledges, and by reason of the small area in contact can be adjusted in the socket. The drawing is made from memory, and may not be correct in all respects.

Another example of successful clamping in the same manner is shown in Figs. 5 and 6.

Fig. 5 is a section through a shaft coupling designed by the writer in 1885. Fig. 6 is an end view of one of the cones. The drawing is taken from a coupling of $2\frac{1}{8}$in. bore, and the bearing ledges on the cone are about $\frac{3}{8}$in. wide, eleven in number, the cone being slit through at one point and partially cut through at three other points, as shown in Fig. 6. This, as will be seen, is the same thing as the chuck just described, and the range of compression, without distortion or bad running, was a good deal increased over cones that had a bearing all over their outer surface.

The limit in this direction, however, was not in the exterior of the cone, but the interior bearing on the shaft. If the cone had been split into four parts it would have closed on the shaft at four or eight bearing points, as the fit was close or loose; but as made, the fit on the shaft was defective when the size of the latter was varied from the standard size for which the couplings were bored.

The coupling shown in Fig. 7 was also designed by the writer in 1866, at a time this subject of cone adjustment came up as a problem in the works. The theory was that a thin shell or sleeve around the shaft, when split open on one side, would close concentrically, and fit on shafts that varied so much as is common in turning and finishing them. The drawing is from a coupling of $2\frac{1}{2}$in. bore, the sleeve being $\frac{3}{16}$in. thick at the ends, and $\frac{7}{16}$in. at the middle.

The conjecture respecting concentric action of the shell was correct for a limited amount of adjustment; but, as in all cases of screw and wedge action, the friction of the screw collar prevented the couplings being drawn up with a common spanner, and by driving on the outer shells with a maul or hammer, the couplings could be made so fast that no keys were required in ordinary use.

These couplings were made both in America and Europe, and perhaps are yet. Their history is not known, but the accuracy of the work required in making them has no doubt prevented successful competition with cheaper modifications.

Fig. 8 represents a coupling the name of which cannot now be recalled. It is included here to explain some features of design peculiar to all mechanism for "connecting," as well as shaft couplings.

It was pointed out at the beginning that the functions of a coupling were to impart a rigidity equal to that of the shafts connected, and to transmit torsional strain equal to the strength of the shafts. To these can be added another rule: that the compression or gripping strain should be enough to prevent movement in the sockets or bore; and a third rule: that all these three functions should be performed by the same members—that is, the same metal employed to secure rigidity should perform the office of compression, otherwise the size and weight of a coupling will be increased in proportion as these functions are independently performed.

Fig. 8 is introduced to illustrate this matter. The transverse strength of the coupling, or its rigidity, is represented in this case by the cross section of the inner shell or sleeve at the middle, where the coupling is nearly cut in two. It will also be seen that the function of compression or fit is performed by the inner pair of rings or collars, and that these have no other office; also that the ring nuts at the end have no function except to press the inner rings on the conical faces of the sleeve.

Applying the rules before named, their truth will be apparent in dimensions of this coupling. It is a cylinder having a diameter at least three times that of the coupled shaft, if made of cast iron, and its weight double that of any coupling in which rigidity, compression, and torsion are all provided for in the same members.

Very good couplings of minimum weight have been made on the same principle as shown in Fig. 9, where the member in compression, *e*, is of cast iron, and the members in tension, *a a*, are of wrought iron. The main shell *e* is in two parts, and the rings *a a* are driven on the tapering ends. Comparing, it will be seen that the two collars *a a* represent or perform the same functions as the four do in Fig. 8, and those in Fig. 9 being of wrought iron, their section can be reduced to one-third, or less than one pair of those in Fig. 8, or, in other words, the outer or enveloping members are, in practice, not more than one-sixth as heavy.

The coupling shown in Fig. 9, so far as we know, was first made by J. H. Cooper, of Philadelphia, and, aside from requiring to be driven on by blows, are among the best of their class. It is true the inner shell has to be heavy to furnish the required rigidity, consequently is not capable of much flexure; but the same remark applies to nearly all kinds of compression couplings—namely, they require that the coupled shafts be of accurate diameter in order to hold safely.

(To be continued.)

New Reservoir Pen.

CONSIDERABLE ingenuity has been displayed during recent years in the construction of self-feeding or reservoir pens. In the early arrangements much trouble was experienced owing to leakage and the difficulty of regulating the feed of ink to the nib. In the new "Pelican" pen, recently introduced by Messrs. Thomas De La Rue and Co., Bunhill Row, London, both these defects have been most successfully overcome. In this arrangement, the reservoir, which is of more than ordinary capacity, is closed at one end in the usual manner by a screwed plug, removable for filling. The other end is made concave in form, and is closed except for two small holes, one for the emission of ink, the other for ingress of air. On the outside of this end of the reservoir the pen carrier is screwed. This carries the nib, and has holes for air and ink corresponding to those in the closed end of the reservoir. The inside of the pen carrier end is made convex in form, so that when screwed completely home the two curved surfaces form a tight joint, as in this position the feed holes do not come opposite to each other. The flow of ink may be regulated to the greatest nicety by adjusting the position of the pen carrier on the screwed end of the holder. A gold nib, iridium pointed, is employed, which is very elastic, and being non-corrodible lasts a considerable time. The pen is exceedingly well made and convenient to use, and besides writing instantly and continuously, has the advantage of writing for a short time with the reservoir closed. It is also claimed that the reservoir preserves the ink in perfect condition for an indefinite period, and that the pen may be carried in any position with absolute safety.

The Iron and Steel Institute.

(Concluded from page 224.)

PUDDLING IRON.

A PAPER was then read, entitled "Notes on Puddling Iron," by Mr. John Head. He mentioned that in the paper read in 1868 by the late Sir William Siemens before the British Association, the theory was advanced that the oxidation of carbon, silicon, and other substances to be removed from pig iron during puddling, could be entirely effected by means of oxygen obtained from the fettling used for lining the pan, or by that obtained from hammer scale, or other iron oxide thrown in expressly with the charge. That theory had been supported by an experiment made in an open-hearth steel-melting furnace, and had been generally accepted by various writers on the subject. The theory, observed the author, could be realised in practice in a puddling furnace, provided the pig iron used did not contain an excess of silicon, or that time could be allowed and a low furnace temperature ensured for its elimination. The experiment made by Sir William Siemens in the open-hearth regenerative gas furnace had required six hours for its accomplishment; the pig iron was melted and purified upon a sand bed and under a protecting covering of glass. That experiment had proved that carbon and silicon could be eliminated from molten pig iron without flame or air coming in contact with the metal under treatment. Many regenerative gas puddling furnaces had been set to work for puddling iron, and were constructed to carry out the process in accordance with that theory. In some cases those furnaces gave every satisfaction, whilst in others difficulties were experienced which induced Sir William to make alterations in the flame-ports of his furnace. In this arrangement a certain amount of contact between the flame and the iron to be puddled was secured, and with this modification all complaints ceased. When he made that alteration Sir William was engaged in perfecting the details of manufacture of the Siemens steel process, and he was thus prevented from following up the puddling process. Owing to chemists not being usually employed at ironworks, analyses of the iron puddled and of the puddled bar produced were not supplied, but it was thought that the reason why alterations were required in the pudding furnaces erected at some works was that the pig iron contained a larger amount of silicon than at other works.

There were not many analyses of the various brands of pig iron used for puddling, and of the puddled bar produced therefrom, to be found in metallurgical books and papers, but the author had managed to present in tabular form the only analyses of that kind that had been found. The analyses quoted showed that the puddling operation should be effected in less than two hours' time with practically complete elimination of silicon, and that when a certain temperature was attained in the puddling furnace the elimination of silicon ceased. In the case of Canadian pig iron experimented with, the percentage of silicon contained was only 1·11 when fused. That was extremely low, and the whole of it disappeared when the iron reached the boiling point, or, in other words, when the highest furnace temperature had been attained with such a low proportion of silicon that pig iron might very well be puddled in the Siemens furnace by relying entirely upon the oxygen contained in the fettling. At some works where those furnaces were erected and complaints arose, it was thought that the pig iron contained a large proportion of silicon. Hence the necessity of having recourse to a slight modification of the flame-ports of the regenerative gas furnace so as to obtain some oxidation of the metal by the flame. This was shown by analysis of the pig iron used and the puddled bar produced at works in England where ordinary iron was made. In this case an arrangement of flame-ports was adopted to enable the oxidising action to be effected either by burnt gases or unburnt air, or, again, by the admission of cold air upon the surface of the iron in fusion, and particularly to allow the furnace to be worked at will with an oxidising or reducing flame, great importance being attached to the use of a reducing flame during the balling up of the iron. An average analysis of Spanish pig iron used for the production of high-quality iron, and analyses of the good and other finished bar iron made therefrom, gave good results. The only difference between the one kind and the other was that the inferior bar iron was found to contain 0·329 per cent. of silicon, and the good bar iron only 0·103 per cent. In the presence of the favourable results obtained in working the new-form Siemens furnace for puddling, the author did not consider it surprising that many new applications of those furnaces had been made in England and abroad. The analyses of pig iron, or mixtures of pig iron used for puddling, and of the puddled bar produced, were scantily dispersed through literature relating to the puddling process, but he concluded that those he had given were sufficient to warrant the deductions arrived at and mentioned above.

COMBINED BESSEMER AND SIEMENS-MARTIN PROCESSES.

The last paper read was "On the Manufacture of Basic Steel at Witkowitz," by Mr. P. Kupelwieser. He observed that if the small amounts of steel manufactured for special purposes in crucibles and refineries were left out of consideration, it was evident that much the greater quantity of steel and ingot iron was produced in the Bessemer process. The cost of converting pig iron into steel was lowest in the ordinary Bessemer process, considerably higher in the basic process, higher still in the acid Siemens-Martin process, and highest in the basic Siemens-Martin process. A rapid oxidation, such as took place in the Bessemer converter in the first stages in the method of conversion into steel, and a slow oxidation during the later stages, such as occurred in the Siemens-Martin process, appeared to the author to be the method best suited for the manufacture of an equable product, provided it was found practicable to carry out this combination, which was, in fact, an amalgamation of the Bessemer and Siemens-Martin processes. Such a combined process had been employed at Witkowitz for a year and a half, and the results obtained outweighed any of the disadvantages attaching to the process.

The author, after describing the circumstances under which the work was carried on, gave figures showing a complete view of the process. The data showed that the consumption of coal, lime, and ore, and the conversion of pig into steel in the basic Siemens-Martin process, were so low as to reduce the cost of conversion about 10s. per ton (although only 56 per cent. of melted pig is used) in comparison with the cost of conversion in the Siemens-Martin furnace from the commencement, and only amounted to the same as in the basic Bessemer process when carried out on a large scale. If it had been possible to employ still larger quantities of melted pig, the results would probably have been still more favourable, and would not have exceeded the cost in the Bessemer process with non-phosphoric pig. This combination of processes, the author concluded, enabled the conversion of pig into steel to be effected in the cheapest possible way under those unfavourable circumstances in which the pig contained too much phosphorus for the acid Bessemer process, and too little for the basic Bessemer process. The method of working also enabled the pig iron to be used direct from the blast furnace with good results in works where it was possible to do so, and where it was previously done but abandoned for certain adequate reasons.

The Junior Engineering Society.

AT a recent visit of this society another inspection was made of the Tower Bridge Works, through the kindness of the engineer, Mr. J. Wolfe Barry, M. Inst. C.E., a party of upwards of eighty being present. Arrangements for their reception were kindly made by the resident engineer, Mr. E. W. Cruttwell, M.I.C.E. Since the society's visit to the works in the month of July last, it was noticed that the suspension chains had been completed, and the suspension rods, together with the greater part of the shore spans, erected. The lifting spans had been experimentally rotated, and the rack quadrant and machinery for working the lifting spans are being adjusted. The masonry of the abutments had been completed, and that of the towers was advancing towards completion. The erection of the steam pumping engines and boilers on the south approach was finished; the pressure pipes in connection with the hydraulic engines in the piers were being laid, and the paving of the approaches was proceeding. For the facilities extended in connection with the occasion, the thanks of the members were expressed by the chairman, Mr. Sidney Boulding, M.I.Mech.E.

Shipbuilding Notes.

Messrs. J. and J. Denholm, Greenock, have given an order to Messrs. Scott and Co., Greenock, for another steel screw cargo steamer of 1250 tons gross.

Orders have been received at Chatham for the immediate commencement of a new cruiser, to be named the "Minerva." The vessel will cost about £400,000.

Messrs. Ramage and Ferguson, Leith, have secured an order to build a steamer of about 700 tons for Messrs. J. T. Salvesen and Co., shipowners, Grangemouth, for their Baltic trade.

On the 10th inst. the new steel steamer "Embiricos," built by Sir Raylton Dixon and Co., Middlesbrough, and engined by Mr. John Dickenson, Sunderland, left Tynemouth for her loaded trial. The average speed on the measured mile was $10\frac{3}{4}$ knots, being in excess of the contract speed.

Messrs. Russell and Co., Greenock, have contracted to build for the Burrell Line, Glasgow, two steamers each of 4000 tons, and two others each of 5000 tons. The engines for the former will be supplied by Messrs. Kincaid, of Greenock, and for the latter by Messrs. Blackwood and Gordon, of Port-Glasgow.

On the 3rd inst. the steel screw steamer "Penarth," which has been built by Messrs. Wm. Gray and Co. Limited, of West Hartlepool, and engined at the Central Marine Works of that company, went for a trial trip in Hartlepool Bay. The dimensions are:—Length over all, 335ft.; breadth, 42·6ft.; depth, 23·1ft. The triple-expansion engines have cylinders 24, 36, and 46in. in diameter, with a stroke of 42in. On the trial a speed of $11\frac{1}{2}$ knots was attained.

The French torpedo boat "Lansquenet," which was launched at Nantes on May 18, has undergone her trials, and has attained a speed of 26 knots, or very nearly 30 statute miles, an hour. The "Lansquenet" displaces 138 tons, is 165ft. 4in. long and 15ft. 8in. broad, and draws 4ft. 3in. of water. She has twin screws and two sets of triple-expansion engines, which together indicate 2800H.P. At present she is the fastest craft in the French Navy.

The new fast gunboat "Onyx," built for the Royal Navy by Messrs. Laird Bros., Birkenhead, has been delivered to the dockyard authorities at Sheerness as completed by the contractors. The "Onyx," which is one of six gunboats ordered of private firms under the Naval Defence Act, made a good passage from Birkenhead to Sheerness, her engines and boilers working satisfactorily throughout the voyage. The Admiralty have given instructions for her to be immediately prepared for her official steam and gunnery trials. The cost of the "Onyx," including her equipment, is estimated at £57,301.

On Machine Designing.

[CONTRIBUTED.]

(*Continued from page* 198.)

THE BEAUTIFUL IN MACHINERY.

THERE are those who maintain that there is no beauty in machinery; and it must be acknowledged that about some productions, which may charitably be called machines, not much of this quality is apparent. But that there *is* a beauty of its own in every well-designed and finished machine, every true engineer will testify—a beauty as real to the educated mind as that existing in a magnificent building, a lovely painting, a delightful poem, a graceful symphony, or in any other work of art. The engineer perceives in a machine many beauties that lie concealed from the generality of mankind, for the perception of the beautiful in machines, just as in all other objects of beauty, depends in great measure on the cultivation of the understanding.

Let us see whether we cannot discover some elements of this beauty in machinery. In the first place, ornament is not beauty. Beauty is one thing; ornament may be quite another. If ornamentation be not harmonious with the functions and general characteristics of the machine, it becomes a blemish. Extraneous ornamentation is, in general, to be avoided in machinery. It is useless, expensive, and offensive to the educated mechanical taste. As in the individual anything savouring of affectation is sure to offend, so also in machinery anything "put on" merely for the sake of adornment or show is an objectionable eyesore to the true mechanic.

And yet there are occasions when a little judicious ornamentation adds to the beauty of a machine. Machinery which appears much in public, and is subjected to the gaze of the non-technical, may suitably be, and usually is, somewhat decorated. Exhibition machinery, locomotives, fire engines, and bicycles, are instances of this.

But the *true* beauty of a machine is of form rather than of colour. It resides in its excellent workmanship; its just proportions; its graceful, flowing outlines; its evident fitting adaptation of means to the end proposed. It appears in the skilful arrangement of its ingenious mechanism; in the reflection which it presents of the designer's mind—for, as was aptly remarked by the "Engineer" in a recent article on "Fashion in Steam Engines," "every designer has within him a certain æsthetic sense, and the external appearance of his engine is to a large extent the manifestation and the work of that sense."

In machinery, all fancy knobs, beadings, flutings, mouldings, capitals, arches, and other adornments borrowed from the domain of architecture, and sometimes seen in old machinery, seem incongruous and objectionable to modern tastes and ideas. The framing of early side-lever marine engines, as well as some antique machine tools, was notably architectural in character, and therefore most unsuitable. There is about these early designs an unsightly angularity which compares unfavourably with the flowing contours of modern machinery.

Castings always look best of broad, well-swept, curvilinear profiles, and are, moreover, much stronger thus. Sharp, re-entrant angles are to be avoided; and all edges should be well rounded, and the corners have large fillets. Cored sections look better than ribbed sections. The outlines are not so harsh, and there is a roundness, a flowing quality, and an absence of angularity, which do not exist in the latter. The bearing bosses of framing should be barrelled; they look better than when cylindrical. The smoothness and finish of the castings, due to careful moulding and rubbing down, have also much to do with the appearance of a machine.

The works of Nature present many pleasing examples for our instruction and guidance in the proper disposition of material for strength, combined with beauty. In trees, for example, we see how elegantly the trunk tapers and spreads outwards at the base, its roots extending wide. This the engineer imitates in the framing of his machines. The method of stiffening a thin web by ribs, feathers, or corrugations; the arched, dished, and hollow cylindrical forms—light, strong and beautiful—are also seen in many of Nature's matchless works.

A symmetrical disposition or balance of parts about a centre line—the juxtaposition of right hand to left hand—is an element of beauty in machinery. Hence, in this respect, a Webb's three-cylinder compound locomotive, for example, is more beautiful than a Worsdell two cylinder compound, because the former has the cylinders symmetrically disposed about the centre line of the engine, as is also true of an ordinary non-compound locomotive. It would look odd, for example, to see the funnel of a locomotive set out of the centre line of the boiler.

A fine modern locomotive is perhaps, on the whole, one of the most beautiful of machines. The contemplation of a noble engine fills the mechanical mind with a feeling of pleasure akin to that experienced by the artist as he surveys a beauteous work of art.

A neat arrangement of the parts of a machine, including reasonable compactness, adds to its elegance and attractiveness; but *crowding* is a distinct fault, to be carefully avoided whenever possible. But, owing to various restrictions, the ingenuity of the designer has often to be exercised to get a maximum amount of machinery into a minimum of space.

Another element of beauty is the contrast of different parts—of the polished with the painted, of the bright with the black, and of the iron with the brass work. Large areas of polished work are to be avoided, for, besides being expensive, they are apt to produce a gaudy appearance. There is too much finery; too little contrast. Narrow bands and smaller areas of polished work look better. They are neater, more tasteful and pleasing. In a fairly large plate wheel, for example—say for the back gearing of a heavy lathe,—instead of brilliantly polishing the whole thing—rim, web, and boss,—as is usually done, a better appearance may be produced with less labour, by polishing only the edges of the rim and the faces of the bosses, leaving the web smoothly turned only, afterwards to be suitably painted in colour, harmonious with the rest of the machine and its surroundings.

Still another beauty in a machine, seen more especially in engineers' tools and fine machinery and philosophical instruments, is the finish imparted to plane-scraped surfaces by the process of "mottling"—a term perfectly familiar to tool fitters, however unintelligible to others. The operation is performed by means of a scraper, well ground and nicely oilstoned, which is applied, with some pressure, to the plane metallic surface under manipulation, given a peculiar wrist motion, and traversed diagonally across in parallel lines, until the whole area has been covered. It is then gone over again, so that the path of motion crosses the former diagonally, a wavy, mottled appearance of the surface being thus produced. It requires a good deal of practice to do this with perfect uniformity, but when skilfully done the result is very pleasing.

Lastly, there is an agreeable contrast between cast and riveted work; a difference which, although existing for a reason altogether apart from appearance, yet produces a certain degree of relief and satisfaction to the eye.

One consideration that may, to some extent, determine the degree of finish to be given to any piece of machinery, is that the attendant naturally takes a greater pride in a highly-finished machine than in one of ruder construction, and consequently evinces a more lively interest in its performance and the maintenance of its efficiency. Another, and perhaps more important consideration—at least from the manufacturer's point of view,—is, that a machine which looks well is also, if efficient, very likely to sell well. Sometimes, in order to suit fastidious customers, it is necessary to give an appearance of power, strength, and massiveness much greater than would otherwise be at all needful.

(*To be continued.*)

The Relations of Chemistry to Foundry Practice.—III.

Sulphur.—Sulphur occurs as free or native sulphur in yellow finely-shaped crystals, and is found abundantly in volcanic regions. It takes fire easily and burns with a bluish flame to sulphur dioxide, giving off offensive odours. It is used in making matches. Sulphur is plentifully distributed among the minerals and ores of the whole globe. The extent to which it became associated with all metallic groups is indicated by the amount of sulphur-containing ores used in smelting the rarest metals—gold, platinum, silver, and a number of others. As examples of this widespread distribution, copper, lead, zinc, and even iron are metals smelted from sulphurous ores. To the early workers at metallurgy sulphur was a much dreaded ingredient, and even with modern chemical knowledge and mechanical appliances it is a baneful and capricious element. To the old iron workers it was one of the "devils." Combined with iron, a common and abundant mineral called pyrite (sometimes "iron pyrites") furnishes the material for making one of the most important acids in use—sulphuric acid, commonly called vitriol. The by-product from this process, so-called "purple ore," is considered by some misinformed persons to be a suitable substance for making into pig iron. This same mineral, pyrite, is found in limestone, in anthracite coal, in bituminous coal, and hence in coke, and is termed by miners "coal brasses" and "sulphur." It can be easily understood in consequence why, with ores comparatively free from sulphur, this unfaltering companion finds its way into pig iron or any kind of iron or steel produced therefrom. Together with its occurrence with the ores of iron, another mineral containing copper is also found. We will endeavour to point out to what extent sulphur is harmful in cast iron.

Aluminium.—Aluminium is the next element to which our attention is directed. This metal, through the publicity given to recent modes of cheap extraction, is tolerably well known. It is a silver-white soft metal, capable of being hammered to the thinness of gold foil or drawn into the finest wire. It is little over twice as heavy as water, and three times lighter than iron. Weight for weight it has nearly the strength of iron, but of course its increased bulk and higher cost operate against any immediate prospects it may have of superseding iron for general use. Aluminium takes a high polish like silver, but, unlike that metal, will stand long exposure to corrosive gases without being tarnished. It can be worked cold and hot, and is in use to-day for making surgical instruments, cooking utensils, roofing plate, and a class of like articles. In the year 1891 the United States alone produced 150,000lb. of aluminium. Its oxide is a common ingredient of soils and clays, such as fire clay, or kaolin, marls, slates, etc. Other forms of the pure oxide of aluminium are to be found in the precious gems, ruby and sapphire, the native crystalline occurrence, and in the less valuable varieties, corundum and emery. In hardness the latter varieties stand next to the diamond. In the metallic state, or as the oxide, aluminium forms the base of a number of useful alloys and salts. Porcelain, earthenware, and glass are some of the products in which the oxide is an ingredient. This oxide, or alumina, is the only oxide of aluminium. As such, it is a common constituent of nearly all iron ores, and is hence introduced into the blast furnace, where, under certain conditions, minute quantities of metallic aluminium are reduced and combine with the alloy of pig iron. The tenacity with which aluminium holds to its combined oxygen makes it exceedingly difficult of reduction, and recourse is had in modern times to the more intense heat and reducing power of the electric current. The exact influence of aluminium upon iron is not yet decided, and its employment to advantage is still the subject of experiment. As far as possible we will treat of the facts in this connection.

Arsenic.—Arsenic is a metal having pronounced peculiarities. It is brittle, of a bright greyish colour, and almost as heavy as iron. It will not fuse except under certain conditions, owing to its highly volatile character. Heated to dull redness with exclusion of air, it disappears as a perfectly colourless vapour, which has a penetrating garlic-like odour. In the metallic state this peculiarity serves for its detection, since the smallest quantity burned in the air takes fire with a bluish flame, and while it is thus chiefly converted into the trioxide, the heat is sufficient to volatilise some of the metal, which gives off its characteristic smell. It is very readily reduced to the metallic state. The trioxide, arsenious oxide, acid so-called, is a white powder, and in soluble compounds is a dreadful poison. Arsenic occurs in the free state. It occurs combined with sulphur compounds generally, and in this state is associated often with nickel in the ores of iron. Although so highly volatile, and having properties opposed to the conditions which would bring it into the hearth of a blast furnace, yet it frequently enters pig iron, and in any appreciable quantity is productive of injurious effects. From its association with sulphur, arsenic is sometimes found in fuels. I have taken crystals of arsenic trioxide from the crucible lining in a blast furnace which had used materials in which arsenic was never suspected.

Titanium.—Titanium is a metal strongly resembling tin. While it is a rare metal, its dioxide, called titanic acid, is a frequent impurity in the ores of iron, notably the magnetic ores, and accordingly the metal is usually met with combined with pig iron. In the blast furnace titanium has a tendency to accumulate, and it is nearly always to be found in the hearth after blowing out a furnace. It is in the shape of beautiful copper-coloured cubes and octahedrons, and is combined in this state with certain other elements. P. W. Shimer has found that titanium exists in pig iron, combined with carbon, and has succeeded in separating the compound in the state of minute symmetrical crystals.

(*To be continued.*)

Trade Notes.

The Russian Government have placed an order for twenty-eight locomotives with the Poutiloff Ironworks Company, Russia.

The Sheffield Corporation have placed a contract for an iron bridge with the Stanningley Iron Company Limited.

Messrs. Holme and King, of Liverpool, have secured the contract for the extension of the overhead railway in that city.

Messrs. Spittle and Co., of Newport, have contracted to supply 410 tons of cast-iron pipes to the Tredegar Local Board.

The Shotts Iron Company's head office has been removed from 27, Charlotte-street, Leith, to 130, George-street, Edinburgh.

Messrs. Sampson and Co., of Stroud, are making a double leather belt 5ft. 3in. wide and 110ft. in length to transmit 500H.P.

The International Nickel Company Chicago, are erecting a reduction plant at their nickel mines, near Riddles, Douglas County, Oregon.

We are informed that Messrs. J. Sagar and Co., of Halifax, have opened a London office at Aldermary House, 60, Watling-street, E.C.

The Italian Minister of Marine has placed an order with the Shelton Iron, Steel, and Coal Company, Shelton, for a quantity of finished iron.

It is stated that Messrs. Bolckow, Vaughan and Co., of Middlesbrough, have obtained an order from China for 12,000 tons of steel rails.

The Neuhausen Aluminium Company made a net profit last year of £16,370, and are distributing a dividend on the paid-up capital of 8 per cent.

The Barrowfield Iron Company, Glasgow, have contracted to supply the special pipe connections for the extensions at the Dawsholm Gasworks, Glasgow.

Messrs. James Watt and Co., Soho Foundry, Birmingham, have secured the contract for the boilers for the Ealing Local Board's electric-lighting scheme.

The Kingston-on-Thames Town Council have accepted the tender of Messrs. Allen and Co., of Lambeth, London, for the erection of the electric-lighting station buildings.

Messrs. Thomas Firth and Sons, Norfolk Works, Sheffield, have received an order from the British Government for the supply of a considerable quantity of armour-piercing shells.

Messrs. Brown, Marshalls and Co., Saltley, Birmingham, have received an order from the Tramways Committee of the Glasgow Corporation for the supply of 110 new tramcars.

Messrs. Robert M'Alpine and Sons, Glasgow, have secured the contract for the construction of the Bridgeton Cross and Carmyle Railway for the Caledonian Railway Company.

Messrs. Ernest Scott and Mountain, electrical engineers, of Newcastle-on-Tyne, have secured a contract from a firm of coal-masters in Scotland for a complete coal-cutting plant.

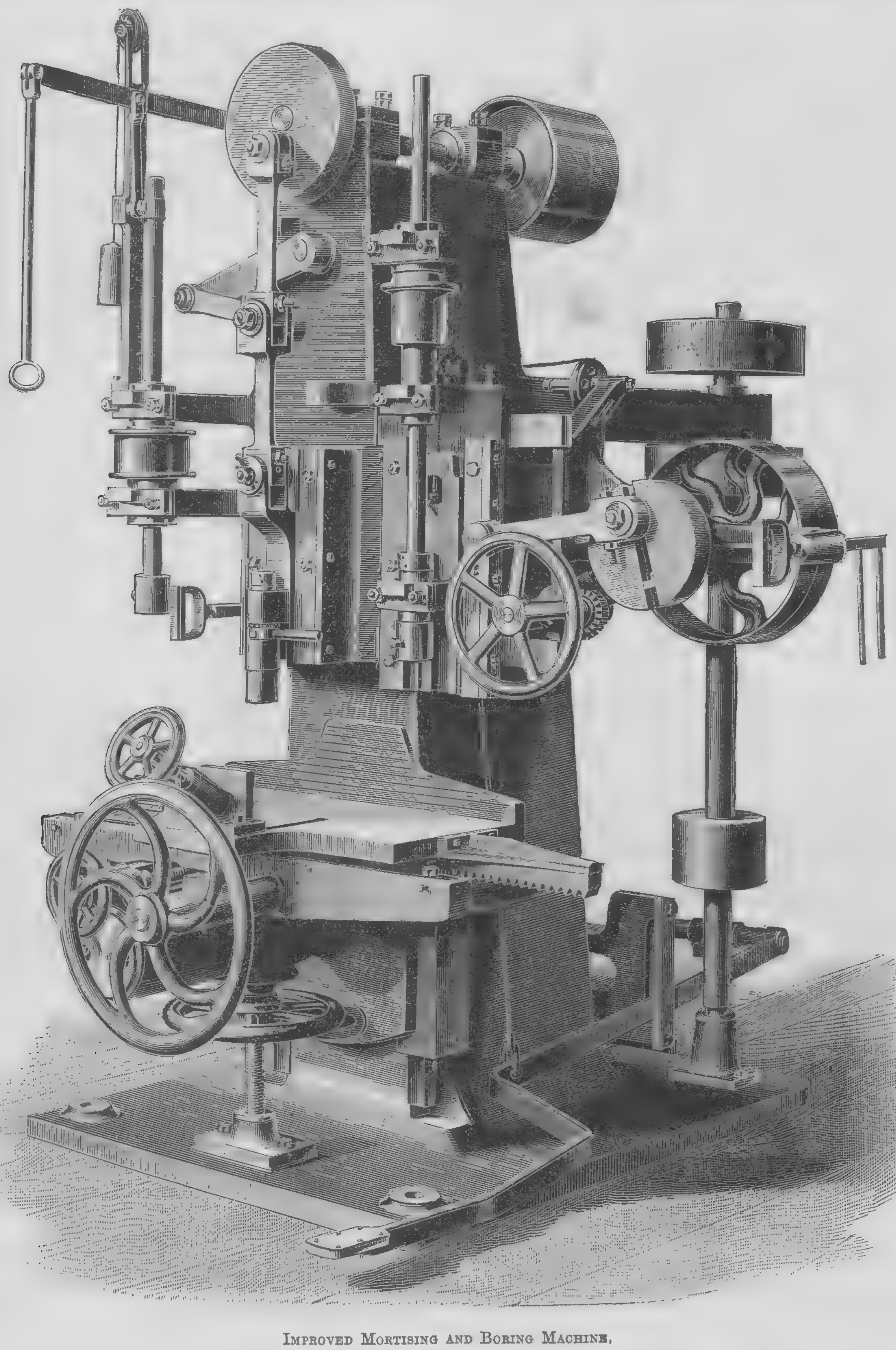
A company has been formed under the title of Messrs. Foster Brothers Limited, to carry on the Lea Brook Tube Works, Wednesbury, formerly in the occupation of Messrs. Ratcliffe and Foster.

The Tubular Frame Wagon Company, of Barrow-in-Furness, have received orders from the Nitrate Railway Company and several other foreign railways for a large number of wagons to be built on the Goodfellow and Cushman principle.

The directors of Messrs. Nettlefolds Limited have decided to recommend a dividend for the second half-year of 5s. per share on the original preference shares, and a dividend of 10s. per share, with a bonus of 10s., on the ordinary shares.

Improved Mortising and Boring Machine.

THE illustration herewith represents a machine used for mortising and boring the timber employed in the construction of railway wagons and carriages. The machine has been specially made for a railway shop in India by Messrs. W. B. Haigh and Co. Limited, Globe Ironworks, Oldham. The routing spindle, which is intended for heavy work, is actuated by a disc. The ends of the mortices made by this spindle are squared by the reciprocating chisel in the centre of the machine. This latter chisel has a graduating stroke worked by a foot-lever, which when depressed gives the full length of stroke, and when released allows the tool to remain stationary while the crankshaft continues to revolve. This arrangement economises time, since it obviates the necessity for stopping and starting.



IMPROVED MORTISING AND BORING MACHINE.

A SPECIAL electric welding car has been constructed at Philadelphia for welding the rails of street railways in position. The car is provided with an electric welding plant, so constructed that current is taken from the trolley wire and transformed into a low-tension current of desired strength. Experiments have been made at Johnstown, and rails of great length have been formed, avoiding the necessity of fishplates and joints, at the same time avoiding the necessity of bonding the track for the return circuit. The time taken is from 4 to 16 minutes for a complete weld.

Hydraulic Lifts.

(*Continued from page* 225.)

THERE are very many kinds of hydraulic lifts, but there are two broad distinctions—viz., the direct-acting and the suspended. The direct-acting has the cage or car thrust up by a ram beneath it, while the suspended has the cage pulled up by ropes or chains from above, and it is impossible to say which system is the better. For low travels no doubt the direct-acting is generally the better, but for very high lifts it is questionable whether the suspended lift is not the safer, as well as the better for other reasons, paradoxical as it may sound. There is little doubt that the suspended lift is safer than the direct-acting lift, having the weight of the ram and cage counterbalanced by ropes or chains attached to the cage, and passed over sheaves at the top of the shaft and down to the balance weights. The cage and ropes, as well as the overhead sheaves, are subjected to much greater stress and strain in this form than in the suspended lift, because of the great weight of the ram which has to be balanced, as well as the cage, the weight of the cage only having to be balanced in the suspended lift.

For moderate heights of travel there is no safer or better hydraulic lift than that known as the hydraulic balanced direct-acting lift. In this lift the weight of the cage and ram is balanced by a separate machine, called the balancing cylinder. The water actuating the lift never enters the lift-cylinder at all, but acts on the actuating ram of the balancing cylinder only. There are several kinds of balancing cylinders, but they all practically consist of a displacement or balance ram, the displacement of which is equal to the displacement of the lift ram. Weights are added to the displacement ram until the pressure created is such that the weight of the empty cage and lift ram will just descend, overcoming friction and raising the displacement ram with its weights. The water contained in the lift cylinder and balancing cylinder oscillates between the two cylinders; when the lift is up it is in the lift cylinder; when the lift is down it is in the balancing cylinder, means being provided for making up any loss of water through the stuffing boxes. The water, in fact, performs the part of the beam in a pair of scales; the actuating water, when admitted through the controlling valve, acts on the actuating ram, exerting a thrust on the displacement ram, increasing the pressure beneath it to the necessary extent to raise the weight of the lift ram, cage, and live load.

The object of the balancing cylinder is to obviate the use of the balance weight attached to the cage by chains or ropes, to get rid of the overhead sheaves, and to reduce the quantity of water used to the smallest practicable amount. In the case of direct-acting lifts working from the Hydraulic Power Company's mains, the one great advantage is the reduction of water used, as the pressure of 700lb. on the square inch would in almost all cases be more than enough to raise the weight of the ram and cage with the maximum live load without any mode of balancing whatever; but a lift without balance (as the ram must be large enough in diameter to give strength as a column), if worked much, would use such large quantities of water that the cost of working would be almost prohibitive. For instance, if we take a lift of 50ft. travel to raise a load of, say, five persons and attendant, or about 9cwt., making 200 trips per day, the ram for this height must not be less than 3½in. diameter, and would use about 21gals. per trip, which would make 4200 per day, or 327,600gals. per quarter, and would cost, according to the Power Company's charges, somewhere about £45. If, however, the same lift be provided with a balancing cylinder, it would only use 8gals. per trip, or 1600gals. per day, or 124,800gals. per quarter, and the Power Company's charge would be £22 16s., showing an annual saving of about £88 16s. by the use of the balancing cylinder; it is therefore well worth the extra first outlay. But even with the balancing cylinder, as now constructed, the same amount of water is used to raise a light load as a heavy one; the maximum amount of water is always used, although the minimum load may be raised. To construct the balancing cylinder and other parts so that a proportionate amount of water should be used according to the weight raised, is perhaps the only direction in which the direct-acting hydraulic balanced lift can be much improved. Great expense is sometimes incurred in order to balance what is called "the loss by protrusion"—that is, to equalise the lifting power throughout the entire travel,—for unless some means is provided for this, the direct-acting lift will start with a much heavier load than it will carry to the top of its travel, for as the lift ram protrudes farther and farther out of the cylinder, the pressure of water acting on its bottom end diminishes according to the depth. In other words, it loses power exactly in proportion to the weight of water necessary to fill the space before occupied by the ram; therefore, if the ram displaces 50gals. of water, it would lose about 500lb. of its lifting power in ascending to the top of its stroke, and must be designed to start with this extra power, hence the loss. In the old form of direct-acting lift, with balance weights attached to the cage by chains passing over top sheaves, the weight of the chains is made to perform this office and equalise the power throughout the whole travel. But where the balancing cylinder is used, some other method must be adopted if the protrusion is balanced at all. In very high lifts it is almost a necessity on account of the great loss of power there would otherwise be, and the extra amount of water that would be used. This does not, however, apply to low-pressure balanced lifts in the same degree as to high-pressure ones, because in the low-pressure lifts the weight of water necessary to actuate the lift may be made to nearly or quite neutralise the loss by protrusion. But this cannot be done with the high-pressure lift, and therefore other devices have to be resorted to, such as enormously heavy chains made of cast-iron blocks for links attached to the moving crosshead of the balancing ram, or immensely heavy levers or moving weights so constructed as to gradually increase the weight pressing on the balancing or displacement ram, thus increasing the pressure in the lift cylinder as the end of the lift ram rises higher and higher, keeping the same pressure always on the bottom end of the ram, no matter in what part of the cylinder it may be. Some of these arrangements for balancing the protrusions are very costly and occupy a large space, the only justification for the extra complication and expense being the extra saving of actuating water, but this generally amply repays the outlay. The economising of water is a very important consideration, as it is a continual saving in the cost of working. This point will be more closely examined later on, when the author describes a system in which a proportionate amount of water is used according to the load lifted.

Direct-acting lifts without any overhead sheaves or ropes, but balanced from below, have been patented and made by the author, but these are suitable only for low pressures. They are quite as safe as the direct-acting lifts with separate balancing cylinder; the power is constant throughout the stroke, and no space is required other than that necessary for the lift itself. The construction is simple and comparatively cheap. The cylinder is made of the diameter or area necessary to give the lifting power calculated as the diameter of the ram in the ordinary old form of direct-acting lift. It is therefore smaller by the clearance round the ram than the old form,

but it is bored the whole length. The ram is made of steel as small as strength will permit, and a piston is attached to its bottom end, the cage being secured to the top. The weight of the ram and cage is balanced by a weight working up and down close to the cylinder in the well, and attached to the piston in the lift cylinder by means of chains or wire ropes passing over sheaves fixed to top of cylinder. The pressure water, after passing the starting valve, is taken to the bottom of the cylinder in the well by a pipe, and the exhaust is taken from the starting valve into the top of the lift cylinder, there being a large exhaust pipe from the top of the cylinder to the drain. It will be seen that the water is always in the cylinder; as the piston rises the pressure above diminishes, and as it descends the pressure above increases, thus equalising the power throughout the entire travel. The protrusion of the small ram is compensated for by the weight of the chains or ropes to balance weight. This form of lift has been found to be very successful for moderate heights, and is eminently suited for very low pressures of water, or where a very heavy load is required to be raised by a low pressure of water.

(To be continued.)

The Chicago Exhibition.—III.

By Our Special Representative.

The present unfinished state of any group of exhibits representing a certain branch of industry, such as steam-engine plant, wood-working machinery, etc., renders a description in classified order impossible. It will therefore be necessary to make suitable selections from those exhibits which are in a more advanced state of completion.

Wood-working Machinery.—The Berlin Machine Works, of New York and Chicago, have a large and well-assorted exhibit of their "Invincible" wood-working machines, of which there are thirteen different types. All the machines are thoroughly well finished, and are not at all crowded together, so that it is possible to get at all parts to examine them. Fig. 7 represents the No. 3 size of a single cabinet planer. The cutting cylinder is made of the finest tool steel, and is fitted with journals 2in. in diameter and 10in. long. The cylinder is belted at both ends. The feed rollers are 6in. in diameter, and are driven by an improved system of gearing, by means of which the first or feeding-in roller is so driven as to keep always in gear, whatever the inequality of the cut. The upper rolls are weighted. The table is supported and adjusted by long inclines, moved by two screws operated by a hand wheel at the side of the machine. The self-adjusting spring pressure bar is so constructed as to yield to the cross as well as the longitudinal inequality of the lumber, thereby holding it firmly on the table, and holding it as closely to the cutters as possible. Two speeds of feed are constantly under the control of the operator, and are both worked by one lever, shown on the side of the machine. The same lever also starts and stops the feed. This is a feature possessed by few other planers, and the benefit derived from this mechanism is plainly apparent. The feed belts are on the inside of the machine, under the table, and are brought to their work by means of a tightening pulley, thus dispensing with clutches in the machine. This machine is made in five standard sizes, the largest size only occupying a floor area of 5ft. by 6ft. 10in. The weight varies from 5100 to 6100lb., according to size of machine.

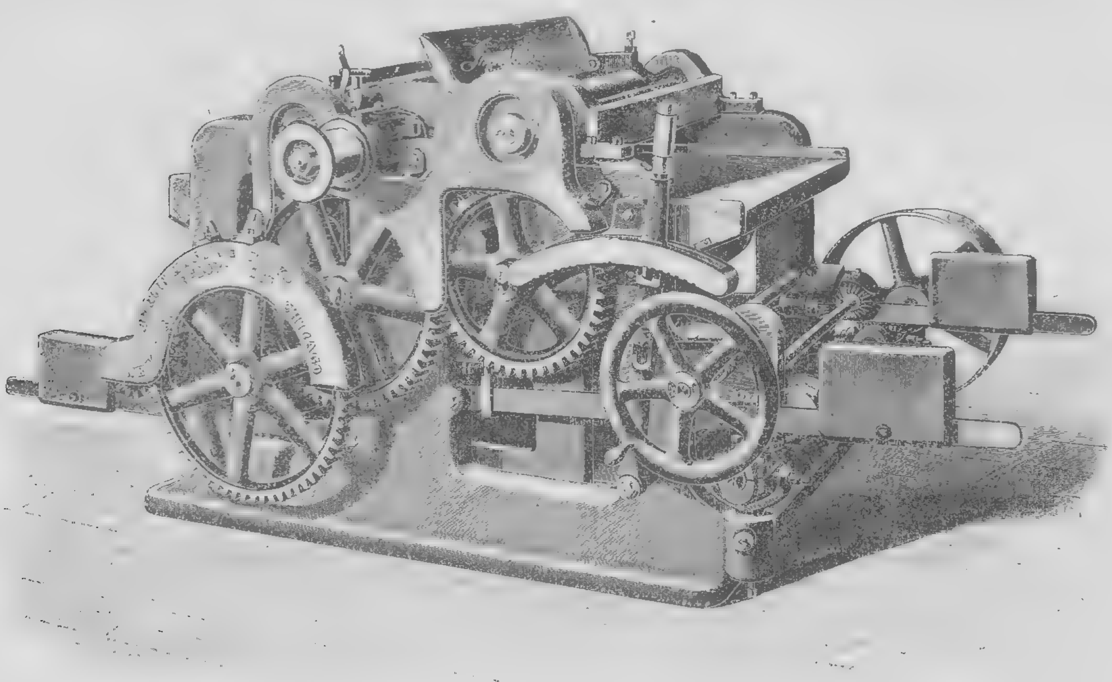


Fig. 7.—"Invincible" Single Cabinet Planer.

Fig. 8 is a No. 3 double cabinet finishing planer. This machine is used for finishing on both sides all kinds of fine woods used in furniture, cabinet, and all other classes of work requiring a smooth, clear surface, leaving little to be done in the way of preparing it for oil or varnish. The frame is cored of a form to withstand all strains which it may be subjected to, and has cast to it suitable slideways for the wedges and inclines supporting the table. The long inclines of the table are moved by two screws, operated by a hand wheel at the side of the machine. The under-cutting cylinder housing is fixed into extra long slideways cast to the side of the table, is adjusted with the table, and also has a separate vertical adjustment by means of the small hand wheel at the front of the machine. The object of this arrangement is to allow the operator to either double or single-surface without having to loosen set-screws or to move from his position at the front of the machine, as a few turns of the small hand wheel will bring the under cylinder into operation or drop it below the table. The feeding rollers—six in number—are 6in. in diameter, all driven by a powerful and positive train of gearing, perfectly fitted and geared. The rollers, after the cut, are all protected by scrapers, to prevent chips or shavings spoiling the work. The cutting cylinders, like that of the machine previously described, are of the finest tool steel, with journals 2in. in diameter and 10in. long, forged from one block. The journals are ground perfectly true, and the cutter is made with lip or cap to form double irons, ensuring smooth work in cross-grained lumber. The pressure plate over the bottom cylinder has a separate vertical adjustment, and is hinged at one end to throw back out of the way, giving easy access to the cutting cylinder for the sharpening or setting of knives. The machine will work from ⅛in. to 6in. in thickness, and is built in a very thorough manner, apparently without reference to cost as regards material or workmanship, thus placing it amongst the first rank of double-surfacing machines.

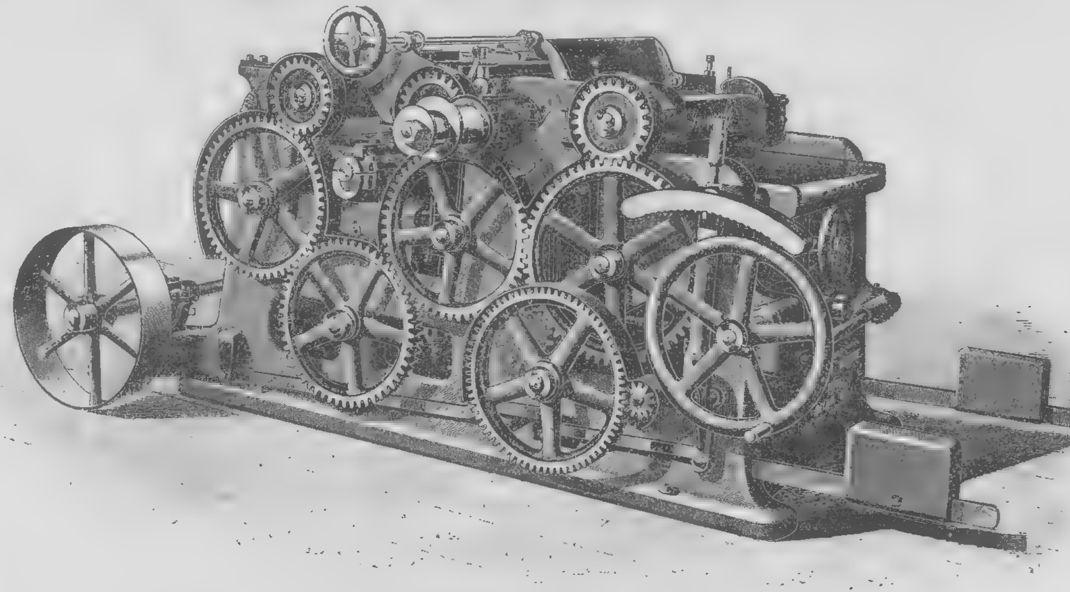


Fig. 8.—"Invincible" Double Cabinet Planer.

The next machine of interest is a glue jointer (see Fig. 9). The framing is made in one piece of casting, cored and ribbed internally, making it very strong to resist all strains to which it is subjected. Countershaft bearings form a part of the frame being cast to it; on the top of the frame is formed the perfectly true slide for the carriage. The carriage, or table, is formed of a central sliding piece and two clamping bars, fitted with a series of spring clamps. These clamping bars are adjusted automatically by means of a lever and a series of screws, and one movement of the lever will clamp or release the work on both sides of the central carriage. Any length can be worked, from 6ft. 6in. to the very shortest piece. The variation for different thickness, from 0 to 3in., is made by the clamping lever, and no time is lost in varying the thickness of stock to be worked. The feed is automatic in its action, and is operated by an improved arrangement of gearing and friction wheels, brought into operation by one treadle, when the carriage and work are passed over the cutters and automatically returned to the starting place, stopping at this point ready for the operator to take out the finished work and put in more stock. At the same instant that the carriage reverses (automatically operated by the same mechanism), the cutter-heads drop down out of the way, so that the stock is not marred or the cutters dulled by the return of the carriage. The cutters are returned and locked in place by the same treadle that sets the carriage in movement. By this means the cutters last very much longer without resharpening. The length of movement of the carriage is regulated by stops from a few inches to the full length of 6ft. 6in. The return speed of the carriage is very fast, so that very little loss of time is incurred by the return. The cutters do not wear out from running against the grain. The saddles which carry the cutter heads have a separate vertical movement to compensate for wear of the heads, and a

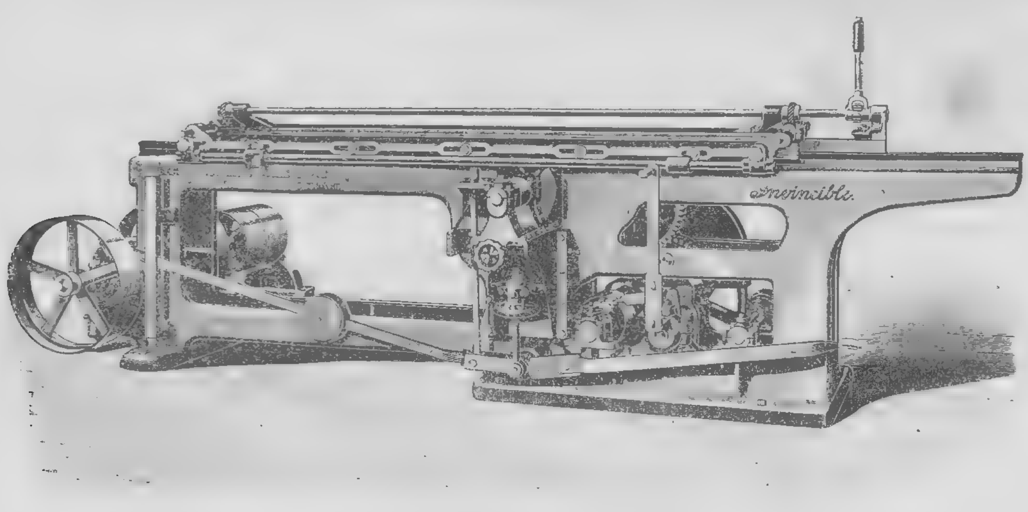


Fig. 9.—"Invincible" Glue Jointer.

horizontal movement to adjust the tongue and groove in the stock worked. The machine is made adjustable everywhere it is required, has large oil ways, and can be oiled while running. All the shafting is of large size, while the bearings have compensation for wear. The actual weight of the machine is 3000lb.

(To be continued.)

The Dead-meat Freezing Establishments of the River Plate.

(Concluded from page 227.)

PROBABLY this may be the proper place to impress upon the reader who has not intimately studied the law of the conservation of energy, the important factor which comes into play in the cycle of operations involved in the production of cold—that is, the necessity of making the air, whilst expanding, do work in the expanding cylinder; because if there was no work done, no abstraction of heat from the expanding air would occur, consequently the air would expand at its initial temperature of 60°, and all the work done in compressing it would have been in vain. This point may be further dwelt upon by giving a quotation from a lecture delivered by Mr. A. C. Kirk, M Inst.C.E., before the Institution of Civil Engineers in 1884:—"Until the development of the mechanical theory of heat by Carnot, Joule, Thomson, Clausius, Rankine and others, no real progress was made in mechanical refrigeration. Thus when we turn to Trevithick's proposal (clever and original man though he was) in 1828 to compress air, cool it, and allow it to escape amongst the water to be cooled, the mechanical theory of heat tells us it would have been a total failure, for the simple reason—then unthought of—that the escaping air did no work as it expanded, and therefore would not have taken heat from the water."

Prof. O. Reynolds, F.R.S., M.Inst.C.E., in another lecture delivered before the same institution, remarks: "Heat as a quantity is independent of temperature, the thermal unit taken being the amount of heat necessary to raise 1lb. of water 1° F."; and again, in the same lecture, he defines: "Absolute temperature is an idea derived from the observed rate of contraction of gases; they would vanish to nothing with the temperature 461° below zero F." The last quotation will explain the former use we made of the words "absolute temperature."

Every practical engineer is aware that in the steam engine the steam in performing work loses its heat, and that the steam entering the condenser or escaping into the atmosphere is colder than the steam was when it entered the cylinder from the boiler. In a similar way the air at 60° entering the expanding cylinder has an absolute temperature of 60° + 461° = 521°, and after doing its work it escapes at 108° below zero, the air having still an absolute temperature of 353°; our air engine has therefore been working through a range of temperature of 168°, or about the same range of temperature as that of a condensing steam engine working at about 150lb. initial pressure. There is, however, this difference to be noted between the two engines: the steam will probably have expanded ten times its original volume, whereas the air will only have expanded three times. The explanation of this is that the air has a less specific (or capacity for holding) heat than saturated steam; also, the steam engine would probably have jacketed cylinders, and part of the steam might be condensed and give up the latent heat of liquefaction. It is the low specific heat of air which makes it so useful in refrigerating machines and enables a low temperature to be obtained by its use.

Professor Dewar lately, at the Royal Institution, made some very useful experiments in which he succeeded in liquefying oxygen at great pressure and at a temperature of 356° F. below freezing, and atmospheric air at a temperature of 377° F. below the freezing point of water. One of the most interesting parts of the experiment was that the nitrogen boiled off first, leaving the oxygen by itself. So far as the writer is aware, the machinery used by his old fellow-student, Professor Dewar, has not been illustrated in any mechanical journal; but in order to effect this result a large amount of work must have been performed, and a low temperature applied, to the highly compressed air. The conclusion we must therefore arrive at, in conformity with the thermo dynamic law already explained, is that the liquid air in again passing into its normal state would extract a large amount of heat from its surrounding substances during its change, or, in popular language, a large amount of heat would have been rendered latent. Of course, at the present time, the method of liquefying air employed by Professor Dewar cannot be commercially employed; but further on we shall show that carbonic anhydride, a more easily liquefied gas than air, is already employed, with marked success, for freezing purposes. We have, however, strong reasons for supposing that in the future liquid air will be the substance used for furnishing the supply of dead meat to this country, and the growls of the British landowner and farmer will be louder and longer. Notwithstanding the apparent injury done to that section of the community, the engineer quietly pursues his course of subduing the forces of Nature to the benefit of his fellow-man.

But to return to the description of the Sansinena establishment, which is situated on the banks of the River Riachuelo, the channel of which, to join the La Plata, forms the entrance to the harbour and docks of Buenos Ayres. The works consist of killing and cooling sheds, pens for confining sheep, engine and boiler houses, and large enclosed cold chambers for freezing and storing carcases. The Riachuelo supplies water for the boilers and for condensing and cooling purposes. There were in 1889 six refrigerating machines, manufactured by Messrs. J. and E. Hall Limited, Dartford, Kent, with the necessary boilers to supply steam to the machines. All of these machines are not working at the same time, but as some of them must be going night and day, it is necessary to have a sufficient number of machines to enable repairs to be effected and to keep down the requisite low temperature in the cold chambers. The work to be done also varies with the number of carcases in store and the varying temperature of the atmosphere, which at Buenos Ayres sometimes in the summer—the busiest season—goes up to 100° or over in the shade.

All the refrigerating machines do their work admirably, the only real difficulty to guard against being that the delivery valves of the expanding air cylinders are liable to get clogged with ice and snow formed from the moisture in the atmosphere, the most suitable lubricant for these valves being glycerine, which does not congeal at the low temperature used.

The cold air is conveyed to the cold chamber by means of wooden trunks, and is made to circulate through the various chambers. The carcases, after being dressed, are hung up in open sheds to cool, and after a suitable time are conveyed by hand into the first cold chamber, where they are frozen hard, and then separately encased in a canvas covering, and are then deposited in the storage chambers to be ready to be transferred into the steamers for Europe. A few turkeys were also frozen on the writer's last visit, and these were protected by open wooden spar boxes. As the Rio Riachuelo is not deep enough to allow ocean steamers to come up to the works, a small tender is employed to convey the carcases to the steamers. The tender is also fitted up with a complete refrigerating plant, so that when a carcase is once frozen it is never thawed until it is put into the hands of the retail butcher in England.

Adjoining the engine house is a small mechanic's shop containing lathes, etc., for repairs, and dynamos for electric lighting. Most of the engineers are Britishers; they are well paid, and every attention is paid to their comfort whilst on duty, which consists of an eight-hours watch in the twenty-four. The engine cleaners, oilers, and firemen are generally Italians, French, or Germans. Unfortunately our countrymen of that class are not much in favour in the Argentine Republic, as *cana*, or white rum, is cheap and wages are good; the Britisher, therefore, is rather inclined to be unsteady. As showing the particular troubles that our engineering brethren in these parts have sometimes to encounter, it may be mentioned that in 1890, when a revolution broke out in Buenos Ayres, a party of Government soldiers were posted to guard the road and railway bridges over the Riachuelo, which are close to the works. As there were at that time 20,000 carcases in store, our engineers were not only employed in keeping their machinery going, but were also exercised not a little in their minds, as in case of an attack being made upon the troops the soldiers would have immediately seized the frozen sheep, which for a time would have made an excellent barricade. However, the necessity for putting good mutton to such a purpose happily did not occur, and the creature wants of the defending army were satisfied by a few live sheep, which were duly paid for.

It now only remains to give a brief description of the latest type of refrigerating machine employed in meat freezing, which is made for using carbonic anhydride gas instead of air. This gas is better known by its old name of carbonic acid, the CO_2 of chemical notation. According to Miller's chemistry, it can be condensed into a liquid at a pressure of from 40 to 50 atmospheres, depending upon the temperature. Power is employed to compress this gas into a liquid, after which the liquid is cooled as low as conveniently can be, and in cooling it the latent heat of liquefaction must also be extracted. All that is required to be done is therefore to allow the liquid to expand again to the gaseous form, when it will extract heat from surrounding bodies, which heat will again be rendered latent, to put it in popular language. The law of the conservation of energy, however, requires a rather longer explanation. We have seen previously that the air in expanding must perform work, or there could be no cooling of the air. In this case the work done was given out to the engine and the air did not change its form. In the case of the liquid gas the heat is required to change the liquid into a gas, and the work done is required to perform this change, or, in other words, to perform internal work, instead of external, as in the previous case.

The carbonic anhydride refrigerating machines, as made by Messrs. J. and E. Hall Limited, consist of steam cylinders, pumps, and copper coils into which the liquid gas is pumped. These coils are surrounded by the cooling water. The pressure required for liquefying the gas is about 50 atmospheres, or 735lb. per square inch. The liquid gas is conveyed into a large copper coil, which is surrounded with brine. The liquid, in expanding into gas, cools the brine to a temperature of about zero F., and this brine is circulated in hollow metal walls, between which the sheep to be frozen are placed. These walls receive the radiant heat from the carcases and freeze them with very great rapidity. One plant erected by Messrs. Hall in New Zealand includes special overhead gear, with endless chains for automatically traversing the sheep from the slaughter-house to the hanging-room, then through the freezing space, and finally to the bagging-room, so that all handling between the slaughter-house and the bagging-room is saved. After the sheep are bagged they are put on to a continuous lift, which takes them to the stores above.

The writer is indebted to Mr. E. Hesketh, the courteous managing director of the Messrs. Hall, for the latter part of the information regarding the New Zealand establishment, who also states that their carbonic anhydride refrigerating machines work with a very much smaller amount of coal—from one fourth or one-fifth, or even less—than that required for their old dry-air machines.

We thus see that within the last few years great improvements have been made in refrigerating machines, and most readers of THE MECHANICAL WORLD are also aware that very great improvements have also been made in triple-expansion marine engines, resulting in great economy in the cost of transport by sea. There is therefore every prospect of the supply of dead meat increasing, instead of diminishing, in the future.

London Association of Foremen Engineers and Draughtsmen.

THE usual monthly meeting of this association was held in the Cannon-street Hotel on Saturday evening, the 3rd inst., when the president and vice-president occupied the chairs, and there was a large attendance of members. After the usual financial and other business had been gone through, the president was asked to vacate the chair in favour of past-president Mr. John E. Reid, who occupied it for the rest of the evening. Mr. Reid then explained that, as most of those present knew, a movement had been initiated about the end of last year for recognising the services of Mr. Coates, the present president and treasurer of the association. It had resulted in a handsome sum having been subscribed by the members, which the committee in charge of the matter had expended in the purchase of a gold watch and illuminated address, and which he had now much pleasure in presenting to Mr. Coates, on behalf of the association, in appreciation and recognition of valuable services rendered as honorary treasurer and other useful work in connection with the association, extending over a period of 21 years. The address, which was beautifully illuminated and framed in a massive gilt frame, and the gold watch, which was a double cased one, bearing an inscription inside and Mr. Coates's monogram outside, were then presented to Mr. Coates; and Mr. Reid, in a few appropriate remarks, expressed a hope that he might be long spared to view the one and use the other. Several other past-presidents and members of the association spoke of their knowledge of the work which Mr. Coates had done on behalf of the association, and the pleasure it gave them to assist in showing that it was appreciated by the members generally. Mr. Coates, in thanking Mr. Reid and the members generally, said his feelings would not allow him to say much, but that he was very much pleased with the kindness they had shown him; and although he felt that his best efforts had not been as successful as he could have wished, he would endeavour to improve upon them, and, if possible, do more both for the association and the individual members in the future.

Metal Trade Memoranda.

The output of ore from the mines of the Marbella Iron Ore Company Limited during the month of May was 1306 tons.

Messrs. Charles Cammell and Co., Derwent Steel Works, Workington, are rolling rails for the Egyptian Government railways.

It is rumoured that the Rio Tinto Company are contemplating the removal of their large copper-reducing works from Aberavon.

The export of gold from Cape Colony during the month of May amounted in value to £439,766, as compared with £381,950 in April, and £326,000 in May, 1892.

The mines of the Arizona Copper Company produced during the month of May 336 tons of black copper and 45 tons of matte, which is equivalent to about 368 tons of black copper.

The total output of gold from the Witwatersrandt Mines, Transvaal, during May amounted to 116,911oz., compared with 112,053oz. in the preceding month, and 99,500oz. in May, 1892.

The copper statistics of Messrs. R. H. Merton and Co. show that the total stocks at the end of May were 49,951 tons, compared with 52,094 tons at the end of April. The deliveries during May were 10,084 tons, against 9731 tons, and the supplies 7941 tons, against 6554 tons.

The members of the Rhenish-Westphalian Crude Iron Syndicate decided, at a largely-represented meeting held at Cologne on the 31st ult., to prolong the syndicate until the 1st May, 1894. The price of foundry pig No. 3, owing to English competition, was reduced from 55s to 53s., whilst the existing prices for No. 1 foundry pig and hematite were maintained.

On the 9th inst. the Pallaflat Iron Ore Mines at Bigrigg, in West Cumberland, were sold by auction under an order of the Court of Chancery. Mr. Burnyeat (Whitehaven) became the purchaser, on behalf of a syndicate, at £20,000. What are known as the Maryport Ironworks, situate at Maryport, were offered at the same time, but no bid was obtained.

The exports of iron from Germany for the first four months of the present year show an increase of 7245 tons, or 1·94 per cent. over the exports for the corresponding period of last year. Rails, chains, wires, and tubes show a small falling off, the main increase being in angles and unworked iron. The shipments to England during the first three months amounted to 32,844 tons, out of a total of 370,304 tons, but a like quantity was shipped to British Possessions abroad.

New Companies.

EAGLE ENGINEERING COMPANY LIMITED.—This company was registered on the 7th inst., with a capital of £7000, in £10 shares (300 8 per cent. preference and 400 ordinary), to carry on the business lately owned by E. Scott and Co. at 3, Cross-street, Manchester, as electricians, electrical, mechanical, metallurgical, heating, and chemical engineers. The rules of Table A apply in most cases. Registered by H. Y. Dickinson, 56, Gray's Inn-road, W.C.

BRADFORD STEEL PIN MANUFACTURING COMPANY LIMITED.—This company was registered on the 6th inst., with a capital of £1,200, in £10 shares, to adopt an agreement made between J. Stead and A. Laycock, to acquire patents, inventions, rights, and privileges for and in connection with the production and making of hackle gill, and card pins, etc., and to manufacture machines for making these articles. The first members of the board are:—A. Laycock, F. Hudson, and C. M. Hunt; qualification, £100 shares. Registered by Waterlow Bros. and Layton Limited, 24 and 25, Birchin-lane, E.C.

OSBORNE PROPELLER SYNDICATE LIMITED.—This company was registered on the 1st inst., with a capital of £2000, in £1 shares, to purchase the patents granted, or proposed to be granted, to C. F. Osborne, of Cape Town, South Africa, civil engineer, for river and marine locomotive, entitled "Reciprocating propellers for floating vessels," and to deal with the said patents for the purpose of turning the same to profit by constructing floating vessels, for sea, river, lake, or, in general, any waters to which they can be made useful or ornamental. Registered without articles of association with the registered office at 16, St. Helens-place, E.C.

WERNER, PFLEIDERER AND PERKINS LTD.—This company was registered on the 2nd inst., with a capital of £30,000, in £10 shares, to adopt an agreement made on the 19th ult. between A. M. Perkins and Son Limited, H. Werner, P. Pfleiderer, and L. P. Perkins, and to carry on the business of civil and mechanical engineers. Many of the rules of Table A apply. Messrs. A. Deane, G. A. Crawley, and H. Werner are the first ordinary directors of the company, at a salary of £50 per annum, and H. Sandars and P. Pfleiderer are the sole managing directors, with £300 a year each as remuneration. Registered by Clulow and Geuld, 9, Gracechurch-street, E.C.

CLAPHAM BROS. LIMITED.—This company was registered on the 1st inst., with a capital of £40,000, in £10 shares, to acquire and take over as a going concern the business of brass and iron founders and merchants, boiler and gasholder makers, and all other manufactures and businesses heretofore carried on by John Clapham, T. Clapham, and William Clapham, under the firm of "Clapham Bros.," at the Wellington, Nelson, and Market-street Foundries in Keighley, Yorks, and to continue the above business in all its branches. The first directors are:—T. Clapham, William Clapham, T. S. Clapham, and S. B. Clapham; remuneration to be determined in general meeting. Registered by C. Doubble, 14, Serjeants' Inn, E.C.

BODILL, PARKER AND CO. LIMITED.—This company was registered on the 1st inst., with a capital of £10,000, in £10 shares, to purchase as a going concern and carry on the business of brass and iron founders, factors, merchants, manufacturers, stampers, and piercers now being carried on in partnership at the Albion Works Great Hampton-row, Birmingham, Warwick, by W. Bodill-Parker, J. R. Parker, and J. E. Parker, and to carry on the trades of brass and iron founders, etc. Until otherwise determined, the number of directors is not to be less than three nor more than five; the first being W. B. Parker, J. R. Parker, J. E. Parker, and J. Parker; qualification, 20 ordinary shares; remuneration to be hereafter determined. Registered office, Albion Works, Great Hampton row, Birmingham.

The Metal Market.

PRICES CURRENT.

LONDON, June 12.

COPPER opened firm at £44 12s. 6d. three months, and the market being well supported prices gradually advanced, cash to £44 6s. 3d. and three months to £44 15s. The latter position, however, afterwards declined to £44 13s. 9d., but rallied again, owing to the firmness of near positions, two months selling at £44 11s. 3d. and one month at £44 10s. In the afternoon cash made £44 7s 6d., but, with three months passing at £44 12s. 6d. on the "kerb," declined under realisations to £44 3s. 9d., and the close was easy at about previous final values. Sales, 900 tons. Settlement price, £44 5s.: English tough, £46 15s.; best selected, £48 5s.; strong sheets, £54 10s.

TIN opened with sellers reserved, and initial business marked a rise of 15s. for cash at £87 10s., owing to covering purchases. Year sellers' option followed at £85 5s., whereupon cash, being scarce, advanced to £87 15s., and £88 5s. was paid for an odd lot of Pyrmont cash. The market later eased under realisations to £87 12s. 6d. cash, and £87 5s. was accepted after official hours. Mount Bischoff ten days' prompt, meanwhile passing at £88. The close was quiet, with cash 10s. and forward 5s. better on the day. Sales, 50 to 60 tons. Settlement price, £87 10s. English ingots, £90 10s. Amsterdam market quiet. Billiton, 5½; Banca, 53½.

PIG IRON.—Scotch has ruled firm at 41s. 4d. cash, and after a turnover of 1500 tons the market closes firm and a shade better than Friday, but Middlesbrough was about 1d. lower. Settlement price:—Scotch, 41s. 4d.; Middlesbrough, 34s 6d.; hematite, 44s 6d.

TINPLATES dull but steady at quotations. I.C. cokes, f.o.b., Swansea, 11s. 6d. to 11s. 7½d.

LEAD has a steady market at unchanged rates. Spanish, £9 3s. 9d. to £9 5s; English, £9 5s to £9 7s. 6d.

SPELTER is quiet and unchanged at £17 12s. 6d. for June shipment.

ZINC SHEETS.—Silesian quiet at £20 10s. ex ship; Belgian steady. V.M. brand £21 5s. ex ship, and £21 2s. 6d f.o.b. Antwerp.

ANTIMONY offered at £38 10s. to £39.

QUICKSILVER remains firm at £6 15s.

OFFICIAL CLOSING QUOTATIONS.

	To-day.
	£ s. d. £ s. d.
COPPER—	
G. M. B.—Cash	44 6 3—44 13 9
" Three months	44 15 0—45 2 6
TIN—	
Fine foreign—Cash	87 10 0—88 0 0
" " Three months	85 15 0—86 5 0
Australian—Cash	88 0 0—88 10 0

PIG IRON—

	Scotch.		Middlesbrough.		Hematite.	
	Cash.	1 m'th.	Cash.	1 m'th.	Cash.	1 m'th.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Close ...	41 4	41 6½	34 6	34 8½	44 6	44 8½
Prev. close	41 4	41 6	34 7	34 9	44 6	44 8½

GLASGOW, June 12.—The pig-iron market was quiet. There was an appearance of buying in the morning, and 41s. 6d. was paid cash for Scotch, but sellers proved numerous, and there was a sharp reaction of 2d. At the second meeting 41s. 4½d. was paid, and there buyers were said to remain, but there was no desire to purchase. In all, some 7000 tons Scotch sold. The Scotch shipments last week were 6274 tons, being a decrease of 975 on the week. The increase for the year now is 2543 tons.

QUOTATIONS:—

	Scotch.		Middlesbrough.		Hematite.	
	Cash.	1 m'th.	Cash.	1 m'th.	Cash.	1 m'th.
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Highest ..	41 6	41 8½	34 6½	34 9	44 6	44 9
Lowest ..	41 4	41 7	34 6	34 9	44 6	44 8½
Close	41 4½	41 6½	34 6	34 9	44 6	44 9
Prev. close	41 4	41 6	34 7	34 10	44 6	44 8½

Public stores stocks in tons:—

	Monday.	Saturday
Connal's Glasgow stores	337,269 ..	337,319
Connal's Middlesbrough stores	67,837 ..	67,800
Hematite—	Saturday.	Friday.
West Cumberland Company.	29,017 ..	29,017
North-Western Company....	18,156 ..	18,156
Hematite Storage Company..	1,500 ..	1,500
Furness Railway Company..	15,359 ..	15,359

Official Gazette.

Partnerships Dissolved.

J. B. GUTHRIE and R. GUTHRIE, iron and steel merchants and agents, Bishopsgate-street Within, E C, under the style of J. B. Guthrie and Son, and Birmingham, under the style of J. B. Guthrie, Son and Co.

J. R. YOUNG and W. T. HARRISON, Manchester, telegraphic contractors and chimney repairers, under the style of the Economic Telephone and Electric Supply Company.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Receiving Order.

JOHN DAINTREE, Salcett-road, Wandsworth Common, S.W., ROBERT SMITH, Dornton-road, Balham, S.W., and ARTHUR NIXON, Wickham-road, Brockley, S.E. (trading as Daintree, Smith and Co.), Upper Thames-street, E.C., ironfounders and merchants.

Adjudications.

SAMUEL MILLER, Langton Cottages, Melbourne-square, Brixton, and Hackford-road, Brixton, S.W., engineer.

CHARLES KNEEBONE, Bettws-y-Coed, Carnarvonshire, proprietor of lead mines.

Letters to the Editor.

**** We do not hold ourselves responsible for opinions expressed by correspondents.*

**** The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

**** Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

SCREW-CUTTING LATHES.

To the Editor of THE MECHANICAL WORLD.

SIR,—Replying to "Screw Jack," in your issue of the 2nd inst., I beg to say that there is no difficulty in cutting a true thread, either right or left hand, in an ordinary lathe, providing that (1) the leading screw is in perfect order, (2) the change wheels have been cut in a machine, (3) the tool is made the proper shape, and (4) the work to be cut is held firmly and does not jump; otherwise a faulty screw will most probably be the result.

"Screw Jack" must not lose sight of the fact that a left-hand thread cannot be cut satisfactorily with a tool made for a right-hand thread.

The difficulty referred to by him is undoubtedly caused by a faulty wheel which he puts into gear for reversing the motion of the tool when cutting the left-hand thread. A little dirt in the teeth is sufficient; but in most cases it is caused by the wheels being cast with the teeth unequally divided, or lumpy and not cut or ground in a wheel-cutting machine.

If the above is not quite clear to "Screw Jack," I shall be glad to give him further help. S. R. F.

Lisbon, June 7.

To the Editor of THE MECHANICAL WORLD.

SIR,—Replying to your correspondent, "Screw Jack," in the issue for the 2nd inst., I may say that I had the same difficulty in cutting left-hand threads, and discovered that the fault lay in the bottom bracket carrying the screw. If "Screw Jack" removes bracket and loose collar and nuts, and faces the wearing surfaces of same true on a mandrel, making sure that the bracket is fitted fairly to lathe bed, he will, I think, remedy his trouble.

Andover, June 10. E. BIGGS.

Miscellaneous Items.

At Cherbourg an electrical canoe is in successful operation. It will run twelve hours at the rate of nearly eight knots an hour.

The address given in our last issue regarding electro-deposition by a painting process, should have been 124, New Bond-street, London.

The United Kingdom only occupies the second place as regards the supply of agricultural machinery to Uruguay, the first place being taken by the United States.

News comes from Burmah that a goldfield, said to extend over an area of 900 square miles, has been discovered at Wuntho. An official report on its character is understood to be favourable.

The length of the canals of the United States is estimated at 3348 miles. The corresponding length of canals in the United Kingdom is returned at 3813 miles, and in France at 10,385 miles.

At the half-yearly meeting of the Birmingham Association of Mechanical Engineers, held on the 3rd inst., a committee was appointed for the ensuing session, under the presidency of Mr. M. A. Driver.

The Standard Oil Company intend using tank steamers in the oil trade with the East. These boats will use the Suez Canal, in order to compete with the Russian tank steamers controlled by the Samuels Syndicate.

The German Mint has been successful in obtaining, in competition, an order to coin for the Egyptian Government gold and silver coins for a large amount, and, as the money has to be delivered at an early date, the employés of the Mint will have to work overtime.

The Rhymney Iron Company Limited have succeeded in reaching the well-known vein of coal called the Brithdir vein. The operations have been in process for many years past, and have involved a considerable expenditure.

A subsidiary combination, formed in the Randt, South Africa, has undertaken the working of tailings in the Zoutpansberg gold fields (which lie to the north of the Transvaal) by the M'Arthur Forrest process, and will pay a royalty to the African Recovery Company.

A fine collection of gold specimens has been sent to Perth from a new goldfield at Coolgardie. It includes three ingots of 150oz. each, two rough lumps weighing 160oz. and 120oz., and three pieces of stone not larger than 6in. by 3in. containing 520oz., the total value being about £10,000.

A larger number of trains run through the Victoria Station, Manchester, in the railway day of seventeen hours, than through any other station in Great Britain, and, it is believed, in the world. Willesden Junction, near London, was thought to bear away the palm, but recent investigation has assigned the premier place to the great Manchester station.

William R. Thomas, Catasauqua, Pa., has patented a method of mixing alloys which consists in pouring the molten ingredients into a vessel in small streams and then working in the vessel a plunger having numerous small holes, the mixing metals being compelled to pass through these apertures at each stroke of the plunger.

The inspectors of mines have prepared a general summary of the mineral produce of the United Kingdom and of the Isle of Man. The value of this produce last year at the mines and open works is given at £82,350,760, as against £91,238,032 in the previous year. By far the greatest portion of this produce was coal, of which 181,786,871 tons were raised, valued at £66,050,451. This shows a decrease on the previous year, when the value of 185,479,126 tons was given at £74,099,816.

Queries.

☞ **Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.**

☞ **Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.**

TURNING CHILLED ROLLS.—Can any reader oblige me with any information on this subject?—T. A.

WOOD'S AUTOMATIC PRESSURE RELIEF VALVE.—Required the address of the makers of this valve.—BELL AND CO.

OIL MERCHANTS.—Will any reader give me the London address of the Cleveland Lubricating Oil Company, U.S.A.?—A. H.

WALTON WHEEL SCALE.—Required, information regarding the Walton Wheel Scale, or where it can be obtained.—A. L. J.

RAILWAY CROSSINGS.—Given the ratio of angle of intersection, say 1 in 8, what is the simplest method to convert into degrees of the quadrant?—L. V.

CHURCHILL SLIDE VALVE.—Can any correspondent inform me who are the makers of the "Churchill Patent Slide Vale"? Any information would be thankfully received.—J. M.

GUTTA-PERCHA.—Can anyone tell me of a process for melting either raw or manufactured gutta-percha, and how, after moulding, to cause the gutta to set firm and solid?—J. C. W.

RETEMPERING EDGE TOOLS.—Will any reader inform me if there is any method of tempering pattern makers' chisels and gouges that have been burnt in a pattern-shop?—CYMRO.

CLEANING BOILER TUBES.—Will some reader describe a useful tool to remove hard, thick scale from cross tubes in a vertical boiler? Tubes 9in. diameter and 4ft. 6in. long—NOVICE.

WARSOP AERO STEAM ENGINE.—Any information about the working of the above engine, tried about 1870, such as the effect on the boiler, cylinder, piston rod, etc., will oblige—M. R.

GALVANISING.—Can any reader inform me whether it is possible to do galvanising on a small scale, say 3 or 4cwt. spelter bath; also the process of preparing cast-iron work for the bath?—T. J.

CASE-HARDENING FURNACE.—Will any practical reader give a sketch of a good furnace for case-hardening purposes, cutter heating, etc., gas, liquid fuel, or coke, or the name of any maker of such?—LISTER AND CO., Keighley.

EMERY TAPE MACHINES.—I have an emery tape machine that I have a lot of trouble with through the tapes breaking continually. Can any reader who has a similar machine recommend a good tape?—CHEVIOT.

STEAM REVERSING GEAR.—I should be much obliged if any reader will explain the working of a steam reversing gear for locomotives, which I have seen on the following railway companies' engines:—Glasgow and South-Western, Mersey Tunnel, and South-Eastern. A sketch would assist me.—F. TURTON.

FLOWING WATER.—A river flows at the rate of, say, 20 miles an hour. If a tube perfectly smooth inside, of 2ft. diameter, were placed in the stream parallel to its surface, at what velocity would the water pass through the tube? Is there any rule for calculating this, and, if so, where can I find it?—SIGMA.

THEORETICAL DIAGRAMS.—Will any reader sketch and describe the theoretical indicator diagrams which would be obtained from a set of triple-expansion engines, having given—Load on safety valves, 150lb.; height of barometer, 30in.; ratio of cylinder volumes, 1, 2½, 5; total ratio of expansion, 8?—HYPER.

STAKING ON WHEELS, ETC.—Will any reader inform me of the best method of staking wheels or pulleys on shafts, say, with four or six keys? Should they be set true opposite the staking wedge, or opposite the permanent keys? Some information on this subject, or a sketch of same, would greatly oblige—STAKING WEDGE.

KEYS, COTTERS, ETC.—Can anyone inform me what kind of steel is used for making keys and cotter pins as used on most engines? The keys that are bought seem to be of better quality than the so-called mild steel as sold at very little more than the price of fair merchant iron.—STEEL.

CONDENSING COIL.—In constructing a condensing worm and tank, what amount of coils are necessary so that the distilled water may be quite cold, and what would be the quantity of water in tank to obtain the result? How can I arrive at the final temperature of water originally cold which has passed through 500ft. run of 1½in. pipe, the pipes being immersed in a tank containing water at a temperature of 200° F.?—CALOR.

FEED PUMPS.—In working out feed pumps for common high-pressure engines, Molesworth says, p. 493—"Take cubic contents of cylinder and one steam passage and multiply by 4, and divide by proper specific volume for given pressure." Why multiply by 4? There are only two cylinders-ful of steam discharged to one revolution or one stroke of the pump. Then, again, should not the cubic contents of cylinder be taken to cut off only? For instance, if steam is cut off, say, at half-stroke, and initial pressure be 100lb., the specific volume for which is 270, we find a great difference from the plan of taking the full cylinder at the average pressure, which at 100lb. initial pressure will be 75 average, the specific volume for 75 being 353, not to mention the difference in the two cubic capacities. Feed pumps worked out according to Molesworth's rule and others always come out much too large—nearly three times. I shall be glad if some reader will explain this.—COLD WATER.

Replies.

☞ **Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.**

☞ **Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.**

W. R. N.—No address given.

PUMP.—See reply to W. R. N.

IGNORANT ONE.—About 1in. for every 40ft. of span is the usual allowance.

C. E. J.—Mr. C. S. Metcalfe, of Sunderland, will supply you with such drawings.

W. F. RICHMOND.—You will see that we have published your reply in our last issue.

YOUNG ENGINEER.—There are no firms who make a speciality of these valves. Various marine-engine builders use them.

CEDAR.—Apply to Messrs. Thos. Robinson and Son Limited, Rochdale; or to Messrs. A. Ransome and Co., King's-road, Chelsea, London.

C. M. (Camden, N.J., U.S.A.).—There is no list or directory of British shipowners published but there is a list of all shipowners at Lloyds' Register, London.

NORTON AND CO.—Messrs. Combe, Barbour and Combe Limited, Belfast; Messrs. Hunter and Son, Belfast; Messrs. S. Lawson and Son Limited, Leeds; and Messrs. Fairbairn, Naylor, Macpherson and Co. Limited, Leeds.

CONSTANT READER.—(1.) To the sum of the areas of the two ends add the square root of their product, and multiply one-third of this by the perpendicular height. In your case, 78·54 + 29·86 = 108·40, and 108·4 + 10·4 = 118·8. Then $\frac{118{\cdot}8}{3} = 39{\cdot}6$, and $39{\cdot}6 \times 8\frac{1}{3} = 330$ cub. ft.

(2.) Multiply the length by the depth and by the mean breadth. Thus, $30 \times 15 \times 7 = 3150$ cub. ft.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

29th May, 1893.

10,474 ACCUMULATORS for the STORAGE of ELECTRICAL ENERGY. J S Bolton and T J Murday.

10,475 COMPOUND STEAM ENGINES. T Browett and others.

10,478 AIR OR OTHER GAS PUMPS. W J Davy and T W Davenport.

10,489 METAL PIPES USED in ZINC SMELTING. W Rees.

10,492 SELF-LOCKING SCREW-TIPPING APPARATUS as APPLIED to CARTS, WAGONS, ETC. J S and W N Stone.

10,496 APPARATUS for OPERATING STEAM OR OTHER VALVES for FIRE OR OTHER ALARMS. R S Blackburn.

10,499 FILTERS.* E A Scammell.

10,501 HEATING LIQUIDS by ELECTRICITY.* C H Pritchard.

10,503 LAMP GLASSES for SAFETY LAMPS. A G Brookes. (*A Kattentidt, Germany.*)

10,504 BOILER for HEATING GREENHOUSES, VINERIES, and the LIKE. J Poat.

10,505 ROLLING MILLS. J P Bedson.

10,510 APPARATUS USED in the MANUFACTURE of PAPER PULP. W H Cadwell.

10,513 INSTANTANEOUS SINGLE and COMPOUND, also SINGLE and DOUBLE-ACTION HYDROSTATIC POWER MOTOR. H Masson.

10,514 TREATMENT of ZINC and OTHER ORES, and in the RECOVERY of BY-PRODUCTS. W Wright and J B Hamond.

10,519 LIGHTING and EXTINGUISHING of a SERIES of GAS LAMPS, SUITABLE for RAILWAY CARRIAGES.* I Hartig.

10,525 ROAD and OTHER ROLLERS. G V Kings.

10,526 EXPANSION JOINT for PIPES.* J A and J Hopkinson.

10,527 RAILWAY OR TRAMWAY VEHICLES. G Moore.

10,530 WHEELS, PULLEYS, and the LIKE. D J R Duncan.

30th May, 1893.

10,533 Electrical Signalling and Printing Telegraph Systems.* J Y Johnson. (*A S McCaskey, United States.*)

10,534 Utilisation of the Heat Lost by Steam Boiler Waste Gases to Heat the Feed-air required for the Combustion of the Fuel in the Furnace. C le Bris.

10,538 Mills for Grinding Mortar, etc. E Chatham.

10,540 Brushes. R Phillips.

10,541 Tables for Riddling and Picking Coal and other Minerals. G Stevenson and M B Baird.

10,545 Method of Operating Corliss Valves for Steam Engines. G G Rhodes and G Carter.

10,551 Machinery for Winding Hospital Bandages. J C Young and W Gibbs.

10,554 Mode of Utilising the Pressure in Cylinders or Reservoirs of Compressed Gases. The Manchester Oxygen Company Limited and W M Jackson.

10,55· Drying Grain.* F Dresser.

10,563 Sifting or Separating Machines. S Edwards.

10,569 Apparatus for Regulating the Temperature of Electrical Heating, Cooking, or like Apparatus. R E B Crompton and H J Dowsing.

10,570 Apparatus for "Heeling" or Manufacturing the Heel Portions of Boots and Shoes. A G Brookes. (*J W Brookes, United States.*)

10,577 Grease or Lubricant Adapted for Railway Carriage Axle Boxes. E Holden.

10,578 Fans or Apparatus for Inducing Air Currents. J H Pickup and others.

10,580 Gravity Separator and Concentrator.* B J Atterbury and P Ewens.

10,585 Feed Device for Gas Producers.* C W Bildt.

10,587 Moulds for Casting Bricks or Blocks of Scoriæ or Slag. T R Dent.

10,588 Pumps.* P Picot.

10,591 Pneumatic Appliance for Emptying Hollow Vessels containing Fluid.* J L Young.

10,594 Ornamenting or Decorating the Bulbs of Incandescent Electric Lamps. T B Browne.

10,596 Steam Generators. J Sampson.

10,597 Devices for Adapting Electric Lamps to Ordinary Candle Fittings. G S Sluce.

10,602 Production of Gas from Oily Refuse. E S Luard.

10,604 Apparatus for Drying Moulds for Metal Castings.* J Bachmann.

10,606 Setting and Holding Plate-glass for Bevelling. G F Redfern. (*E Hill, Canada.*)

10,607 Machines for Bevelling Plate-glass. G F Redfern. (*E Hill, Canada.*)

10,608 Metallic Alloy. D W Sugg.

10,609 Bolt and Nut Locks. R C Welch. (*J H O'Brien, Australia.*)

10,612 Process for Reducing Crude Peat into a Marketable Form.* A J Boult. (*A A Dickson, ——.*)

10,614 Steam Generators.* A J Boult. (*C H Shaw, United States.*)

10,615 Transmitting Telephonic Signals through Long Distances. J Hines.

10,616 Igniting Devices for Gas Light. R Schlesinger.

10,617 Apparatus for Calculating Photographic Exposures. G F Wynne.

10,618 Machines for Automatically Levelling the Soles of Boots and Shoes.* M V Bresnanan and J J Heys.

10,620 Copper-coating the Hulls of Vessels. T S Crane.

10,623 Printing Telegraphs. D Murray.

10,624 Wheels. W B Smith.

10,626 Apparatus for Producing Reciprocating from Circular Motion. E W Beech.

10,627 Car Brakes. W W Horn. (*G R Elliott, United States.*)

10,630 Combination of Materials to be used for the Manufacture of Electric Arc Candles, etc. T Oddy.

10,631 High-speed Steam Engines and Mechanism Therefor.* J Dow.

10,632 Flotation Chambers for Lifeboats, Belts, and other Life-saving Apparatus. C E Evans.

10 634 Street-sweeping Machines. T J McArthur.

10,635 Mechanical Carpet Sweepers.* W R Lake. (*C A Hammett, United States.*)

10,638 Gas Lighting, Extinguishing, and Controlling Apparatus.* J Sangster.

10,639 Buttons.* A Denk.

10,642 Down-draught Steam Boilers. W R Lake. (*C R and G A Ayer, United States.*)

10,643 Down-draught Steam Boilers. W R Lake. (*C R and G A Ayer, United States.*)

10,644 Down-draught Steam Boilers. W R Lake. (*C R and G A Ayer, United States.*)

31st May, 1893.

10,646 Pioneer Land Traction and Water Steamboat. J Owens.

10,648 Combined Electric Light and Heat Stove. G Mitchell.

10,653 Navigable Vessel. A H Valda.

10,657 Fastening for Railway Carriage Windows. M J Brewer and R Friend.

10,662 Engine Governors. W Sisson.

10,664 Separating Oleaginous or Fatty Matters from Boiler Feed Water. J and G Weir.

10,665 Pumping Apparatus for Mines. A B Brown.

10,671 Self-acting Lubricator for Piston Rods of Steam Engines. J Bradley.

10,672 Apparatus for Hardening and Tempering Steel Wire.* H B Goldthorp.

10,673 Railway Automatic Signalling Apparatus. J Johns.

10,676 Boilers. W and J Cormack.

10,677 Chain Stoppers. T M Grant and A Kelly.

10,681 Apparatus for Manufacturing Boxes out of Paper Pulp.* J Y Johnson. (*P Sohége, France.*)

10,682 Fire Escape. W Barrett.

10,691 Props and Girders for Mines. W Firth.

10,693 Sheave or Pulley Blocks. T Robb.

10,695 Cocks for Water, Gas, Steam, or other Fluids. J L Dubois.

10,696 Insulators for Electric Wires. H H Lake. (*E Hartmann and W Braun, Germany.*)

10,698 Apparatus for Collecting the Fumes from Gas Burners. R S Wainewright.

10,699 Apparatus for Cooling or Hardening Objects of Metal, Alloys, etc., between Plates, Moulds, Dies, or Rollers. E Hammersfahr.

10,700 Evaporating Apparatus.* E B Caird and T J Rayner.

10,704 Signalling Apparatus for Railways. W S Frost.

10,705 Ellipsograph.* W Lehner.

10,709 Drawing Board.* C O Peger and F A Bauermann.

10,712 Station Indicators for Railway Carriages. G Chalmers and C R Mardling.

1st June, 1893.

10,716 Automatic Stop Gear for Fluid Pressure Engines. W B Thompson.

10,719 Code Signal Light. A J Peacock.

10,722 Metal Tubes. P Woodrow.

10,728 Band Conveyers for Minerals. N Greening and Sons and W Holbrook.

10,734 Rotary Engines, Rotary Blowers, Pumps, and Water Meters.* R Johnson.

10,747 Runners for Glass-grinding or Polishing Machines. J J Bate.

10,754 Vaporisers for Engines Driven by Vaporised Oils. T F Carter.

10,755 Recovery of Precious Metals from their Ores. J C Richardson.

10,757 Apparatus for Aerial Navigation. R Stevenson.

10,759 Steam Generator and Superheater. J Bonicard.

10,760 Apparatus for Operating the Brakes of Railways Trains. A Farinetti.

10,761 Rolls for Calendering Paper. A Gray.

10,762 Heat Non-conducting Composition.* H Birkbeck. (*H C Michell, Canada.*)

10,763 Valves. J D Churchill.

10,765 Secondary Voltaic Batteries. E J Clubbe and A W Southey.

10,768 Apparatus for Circulating the Air in Railway Carriages, Ships, etc. W Fenwick and K E H Pollock.

10,770 Apparatus for Applying Lubricators and Conducting Lubricants to Bearing Surfaces. W H and R Thompson.

10,772 Ceiling Roses for Electric Connections. G H Cutting.

10,773 Machines for Covering or Braiding-over Cord Rope Wire. P Jenson. (*A Kreidler, Germany.*)

10,775 Apparatus for Heating by Hot Water. E Edwards. (*F Eicke, Germany.*)

10,779 Complete Combustion of Fuel in Stoves, Furnaces, etc. R Zeiler.

2nd June, 1893.

10,788 Arrangement of Stations for the Generation of Electricity. C A Parsons.

10,789 Pipe Cutters. T R Paxton.

10,790 Slide Valves. J Menzies and R Rogerson.

10,796 Lighting Apparatus with and without Change of Colour. J B Howard. (*A Engelsmann, Germany.*)

10,797 Detachable Belt Fastener. E A Fletcher.

10,798 Propulsion of Vessels and Machines, and Apparatus for Walking on Water. W J Thomas.

10,800 Steam Whistles or Sounders. T and W Morison.

10,801 Gas or Vapour Motors. D R Peebles.

10,809 Boiler Tubes. W Hughes.

10,816 Speaking Tubes. H Binko.

10,820 Rolling Machines.* A B Shippee.

10,821 Regulation of Electric Currents. W S Boult and others.

10,822 Machines for Marking Circular Articles.* A B Shippee.

10,823 Labelling Machines.* C A V Rellgren.

10,824 Plates for Mezzotint or Similar Engraving. R S Clouston.

10,826 Automatic Sprinkling Apparatus and Fire Alarm. H A Poole and T Odcy.

10,828 Thrust Bearing for Propeller Shafts. E R Calthrop.

10,830 Electric Storage Batteries. E Bailey and G M Gordon.

10,835 Apparatus for Cleaning or Clearing Hollow or Grooved Tramway Rails. D C le Bras.

10,836 Railway Signals. G Carmarino and L Braud.

10,838 Apparatus for Producing and Maintaining Motive Power. E W Beech.

10,842 Appliances for Preventing Bolt Nuts Working Loose. W J Welch and F M Hale.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to Sir H. Reader Lack, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O.*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

The Mechanical World

EVERY FRIDAY. ONE PENNY.

All who are practically engaged in Mechanical Engineering or Scientific Industries are invited to avail themselves of THE MECHANICAL WORLD columns for information. We are glad to help the diffident, and, so far as we can, remove the obstacles which frequently prevent practical men from communicating their ideas.

We wish it to be distinctly understood that we cannot, for any consideration, and will not knowingly, allow our editorial columns to become the vehicle for mere advertisements of machinery, apparatus, or anything that falls within our province to notice.

Every correspondent should forward his name and address, not necessarily for publication unless so desired. We do not undertake to return MSS. unless specially requested, and in such cases stamps should always be sent.

All communications relating to editorial matters should be addressed to the Editor of THE MECHANICAL WORLD, at the Manchester, and not the London, Offices.

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☞ Owing to the large demand for back numbers of THE MECHANICAL WORLD, we are compelled to fix the following scale of prices:—Copies published in 1887, 6d. each; 1888, 5d.; 1889, 4d.; 1890, 3d.; 1891 and first half of 1892, 2d. each.

All remittances payable to EMMOTT AND COMPANY LIMITED, Publishers, either at New Bridge Street, Manchester, or 85, Strand, London, W.C.

FRIDAY, JUNE 23RD, 1893.

Another Welding Process.

ALMOST simultaneously with the experimental demonstration of the Julien system of electric forging and welding, referred to in our last issue, comes the announcement that another method, practically identical with the former, has been brought out by MM. Lagrange and Hoho, two Belgian scientists. In this case a suitable vessel is employed having a lead lining connected with a conductor of positive electricity, and containing acidulated water. A pair of iron tongs with well-insulated handles is attached by means of a flexible conductor to the negative pole of the source of electricity. Then, upon the current being switched on, and a bar of iron or other metal, taken up by the tongs, being plunged in the vessel, the immersed portion of the iron quickly becomes red hot, and then assumes a white heat, leaving a glowing surface in perfect condition for welding. The action is the same as in the Julien process, the water being decomposed into oxygen and hydrogen. The oxygen passes to the lead lining, whilst the hydrogen forms a jacket round the immersed part of the bar; and offering great resistance to the passage of the current, the ensuing heat brings the bar to a glowing condition. It is claimed that this method of welding is much more economical than any other system, that the hydrogen jacket surrounding the heated metal prevents oxidation, and that the welding surface is left free from the effects of sulphur and other impurities which are present when iron is heated by a coal fire in an ordinary forge. The firm of Krupp, of Essen (whose name, for some reason or other, is usually associated—generally incorrectly—with every new invention bearing upon the iron and steel trades), is reported to be experimenting with the process in the hardening of steel cannon; whilst at the same time belief exists in Germany that the method may lead to important results in the hardening and tempering of armour plates. This process and that devised by M. Julien seem to be practically the same; they are both in a very elementary stage, and practical developments must be awaited before accepting the claims put forward for the two methods.

Gas and Electric Light.

IT is not surprising, now that the electric light has been largely adopted in this country, and as powers have already been granted for introducing this illuminant in many towns where there is not already a public supply, that the opinion should be expressed that it is a pity the electric light was not handed over to existing purveyors of light to the public—namely, gas manufacturers. This view of the subject was manifested last week in the course of the presidential address delivered by Mr. Denny Lane before the annual meeting in Belfast of the Incorporated Gas Institute. The greater portion of the address was devoted to a consideration of electrical illumination and to a comparison of gas and electric lighting, to the disadvantage of the latter. There is much to be said in favour of each, but we will leave controversial questions on this point to the consideration of the respective presidents of the Gas Institute and the Institution of Electrical Engineers, who are two worthy opponents. Taking, however, municipal corporations who are suppliers of gas, it would no doubt be wise policy for them to combine electricity works with the gas works, but in many towns the opportunity for so doing has passed away for some years. Still, in other cases it is not too late to move in this direction. It is, however, not in the interest of the public that gas companies should be permitted to become purveyors of the electric light, although, as Mr. Denny Lane believed, "they could supply the light on better terms than any separate organisation." That may be true; but having practically a monopoly of lighting, they would then do just as they pleased. With local authorities already managing their own water or gas works, which are conducted in the interests of the inhabitants, the case is different, and the municipalisation of the electric light should be carried out by them. Under such circumstances electrical illumination might, for obvious reasons, be provided on more favourable terms than by an independent company. Gas-company monopolies are already too powerful, and they should not be strengthened by combining with them the supply of electric light. There is no doubt that electric-light concerns will in the future become remunerative undertakings, and that gas companies, which at one time despised that illuminant, although it has in no sense been a competitor, now regret having let the chances pass away of carrying on the business. The present movement is in favour of municipalisation of electric-light supply, and this is in the interest of the public, not only in getting light cheaply, but also in tending to keep local rates at as low a level as possible.

Curious Cause of Rail Fracture.

A SOMEWHAT remarkable case of rail fracture was recently reported in Germany. On a certain section of one of the German lines no less than eighty-one broken rails were found in a single day during the past winter. The investigation which was ordered brought out the fact that on a very cold day the brakes were set on on one of the trucks of a coal train, and were forgotten by the brakesman. The line has some heavy grades, and the sliding of the wheels made large flat spots on the tyres. After a time, it would appear, the brakes went off, releasing the wheels, and the latter, through the resulting pounding on the rails, produced the fractures mentioned. The correctness of this theory would seem to be borne out to some extent by the fact that there were always two fractures opposite each other in the two lines of rails.

Electric Traction a Necessity.

THERE seems reasonable cause for assuming that in a few years hence electricity as a motive power will be an absolute necessity on many tramways; and it is noteworthy that in the United States such a necessity has largely manifested itself. Three of the most important reasons for the rapid extension of electric railways and tramways in that country during the past few years have been (1) the need for a rapid means of communication in and between different towns; (2) the necessity for a more economical method of haulage than is afforded by steam or horse cars; and (3) the rapid growth of new towns, where electric lines have been adopted as the most suitable for dealing with passenger and light goods traffic. As a result of this state of affairs, between 600 and 700 miles of street lines are now operated by electricity, the greater portion being equipped on the overhead trolley system. On the European continent, however, beyond the fact that tramway companies generally desire to work their lines at a lower cost per car mile run than obtains at the present moment, an absolute necessity for introducing electric power in place of existing methods of traction has hitherto not been evinced. Nevertheless, there are certain indications which show that such a necessity has now arisen. Take, for instance, the French capital. There, owing to various causes, the Paris and Seine Department Tramways Company have found their dividends gradually diminish year by year since 1888, and now new lines have to be built, two of which are to be electrically equipped. The increasing demands made upon the company by the Paris municipality render more economical working necessary, and the new lines may help in this direction. Another instance is that of the Berlin-Charlottenburg Tramway Company, which yields no return to the shareholders. The competition of the Metropolitan Railway (Stadtbahn) is so keen, that in order to meet it it has been decided to substitute electric power for the horse cars, and negotiations to this effect have now been concluded. These two cases may be regarded as the commencement of a movement foreboding well for the progress of electric traction. The many unprofitable tramways in England might be made remunerative by the adoption of electric haulage, but owing to financial considerations the time for a transformation of systems has not yet arrived. When it does, the development will be rapid, as has been the case with electric lighting since 1889.

A Large Dredger.

THE Naval Construction and Armaments Company, of Barrow, have recently constructed a new dredger for the Mersey Docks and Harbour Board. The length between the perpendiculars of the "brancker" is 320ft.; breadth, moulded, 46ft. 10in.; depth, moulded, 20ft. 6in.; gross register tonnage, 2560 tons. She is built of steel to Lloyd's highest class, and has amidships eight large hoppers or tanks, four on each side of the vessel, having a total capacity of 3000 tons of sand. These are fitted with Mr. A. G. Lyster's patent hydraulic discharging apparatus. A well is formed up the centre of the ship, between the hoppers, to admit of the working of a sand-pump suction tube, 3ft. 9in. in diameter, through the bottom of the vessel. This tube is raised and lowered by hydraulic pressure, and when lowered can dredge to a depth of 45ft. Large rectangular launders or channels are fitted above the hoppers, with openings over each compartment, to allow of spoil being distributed on the hoppers as required. Two large centrifugal pumps, having suction and discharge pipes 3ft. in diameter, are fixed, capable of raising 4000 tons of sand per hour. These pumps are driven by triple-expansion engines having cylinders 11½, 18, and 29in. diameter by 18in. stroke, and which work at a pressure of 160lb. Rudders are fitted forward and aft, controlled by steam steering gear. The vessel will be propelled by twin-screw inverted triple-expansion engines. The vessel, we may add, has been designed by Mr. A. G. Lyster, under the direction of Mr. G. F. Lyster, C.E., engineer to the Board.

A Large Belt Elevator.

A NOVEL elevator is in course of construction at the works of the Jeffrey Manufacturing Company, Columbus. It is a moving stairway for railroad stations, and consists of travelling trucks of the proper width for stairs, on an endless chain, and with it is a travelling handrail that runs at the same rate of speed. The travelling stairway is intended for underground or elevated railroad stations, the purpose being to put in this apparatus where an elevator would not be desirable. The speed is to be about that of an ordinary walk, and at proper places a landing is formed for the purpose of stepping on or off. The stairway belt is in a state of equilibrium when running, requires no attendant, and involves no waiting, as every passenger is carried as he comes along. All that is necessary is for the passenger to step on and he is quickly taken to the top, while the step continues on its journey. Mr. Wheeler, the inventor, claims that the apparatus will have a capacity for about 6000 persons an hour. The stairway now being built is to be placed in the Illinois Central Station at Chicago before the World's Fair is over, and it will thus be given a severe test.

Couplings.

(Concluded from page 234.)

ALMOST any compression coupling can be strained to clamp a shaft slightly under size, but the surfaces will not fit, and deflection of the shafts from the strain of wheels or belts, or being out of line, will soon produce abrasive wear in the sockets, and failure. The fact is, that compression couplings to fit shafts that vary in size are a myth, except within very narrow limits, not exceeding 0·005 of an inch. Of this, however, more will be said in the end.

Conical screws, wedges, and the various devices for compression, within solid shells that bear the reaction of the clamping force, are all amenable to the conditions pointed out, unless it be in the case of screws, which by reason of their helical exterior or bearing faces can be adjusted to a greater degree than the smooth faces of wedges or cones.

Fig. 10 is a diagram, drawn from memory, of a compression coupling that has been extensively used, and seems to have filled the required conditions of such couplings very well. Compression is derived from flexure of the two members *e e*, these being forced in upon the shaft by two tapering screws *a a*, made with a fine thread and tapped into the slot as shown. The members *e e* are severed at the middle of the coupling to permit independent action on each shaft. These close on the shaft in some degree concentrically, over one half of the shaft's circumference, but it is obvious that a fit is required, otherwise the coupling would soon wear out in the sockets if there is deflection of the shafts.

CLAMP COUPLINGS.

The class we have termed clamp couplings embraces quite a range of modifications, all practically the same in effect and nature, or nearly so, and are, no doubt, the best as well as the most simple that can be applied in an interchangeable system. As pointed out before, the function of closing or the reduction of bore in all devices of the kind is due to flexure, and in

the clamping class of couplings the closing force not only performs the office of compression, but also produces, in a direct manner, the flexure required for closing or reducing the bore.

This can be illustrated by Figs. 11 and 12, which are side and end views of one of the oldest forms of clamp couplings. These were employed by Mr. Robert Briggs, of Philadelphia, a well-known engineer, who died about twenty years ago. They can be seen in substantially the same form in the works of Cail and Co., Paris, the celebrated locomotive builders there. In this

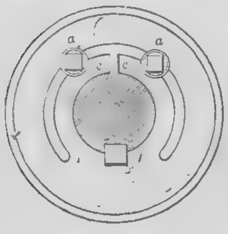
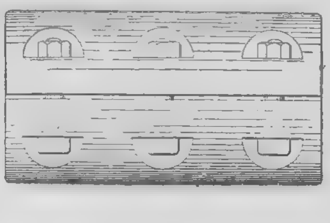


Fig. 10.



Couplings.—Fig. 11.

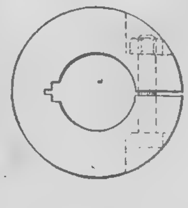


Fig. 12.

latter case they were made not less than thirty years ago, and most likely more than forty years ago, because in 1870 when we visited these works no one seemed to know how long it was since some of the older lines of shafting were connected in this manner.

These couplings are cheap, and when the shafts are carefully turned hold remarkably well, but it is obvious that if strained down upon shafts under size there is danger of fracture at the fulcrum of flexure opposite the slot. There is also the objection

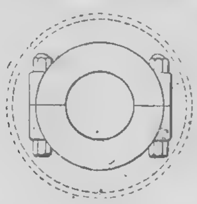


Fig. 13.

common to all couplings noticed this far—that they cannot be removed and replaced without taking down or moving the shafts, and are not balanced in the distribution of the metal.

The exterior contour is free from projections that cause danger, but the clamping screws, countersunk as shown, cannot be turned with a common key, and require a socket one. These couplings have not survived, probably because their merits are not known, but more likely because they do not seem ingenious and complicated enough to meet common opinion.

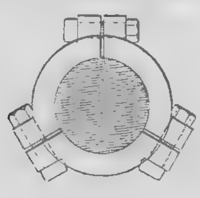
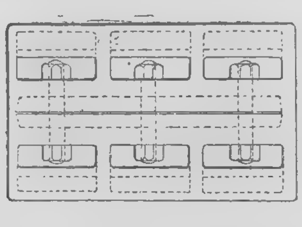


Fig. 14.

Fig. 13 is an end view of the plainest form for clamp couplings, and the first modification among all the compression class thus far referred to that can be removed and replaced without disturbing the shafts connected.

It will seem in controversion of history and common practice to claim that a coupling of this kind, in addition to the advantage first pointed out, is the best that has



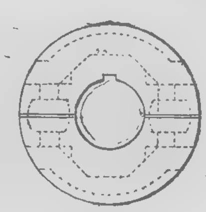


Fig. 15. Couplings. Fig. 16.

been devised, and comes nearest fulfilling the desired functions for devices of the kind, but such a view is in accordance with the facts. Clamp couplings were the first, and no doubt will be the last, among devices of the kind.

The clamping bolts, in addition to expending their force directly in compressing, also tend as directly to bend the shell and close it concentrically around the shafts, such action being perfect up to such limits as the metal will bear, and for any kind of malleable metal far beyond the irregularities of size that occur in fair turning.

One proof of the strength and reliability of couplings of the kind is that they are provided to connect broken propeller shafts at sea, and successfully perform that purpose. A propeller shaft can be compared to an engine shaft from 50ft. to 150ft. long with a fly-wheel on the extreme end, and the enormous strains endured are indicated by the number of fractures that occur. The selection of plain clamps to connect broken shafts of the kind is strong evidence of strength, reliability, and facility of application.

Such clamps when divided into three parts, as shown in Fig. 14, are still better, giving, as we may say, nine points of impingement at the centre and each end of the arcs in contact. It would be an interesting and useful problem to resolve the compression strains in this case with certain assumed proportions. This will be done in a future place.

In some cases these clamp couplings have been housed or covered with a shell, as indicated by the dotted lines in Fig. 13. This, while it makes up a symmetrical device, is expensive, and, moreover, destroys one function—that of removal from the shafts in place, because the covering shell has to be made in one piece.

If a covering shell is made integrally with the main one, as in Figs. 15 and 16, the two shells being connected by flanges or diaphragms between the bolts, as shown in Fig. 16, there will be, with one exception, all the required functions that have been pointed out, with the least possible amount of metal.

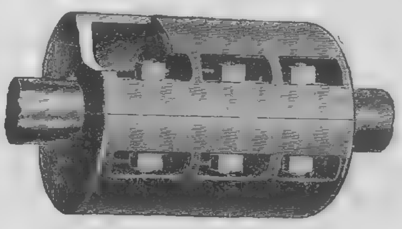
These functions we will repeat as follows:—(1) To secure continued rigidity of the shafts through the coupled shafts; (2) to have a torsional resistance superior to the shafts connected; (3) a smooth contour to prevent danger of catching or winding belts or clothing; (4) to close for compression concentrically; (5) to be removable without taking the shaft down. To these conditions may be added some others of less importance, such as an avoidance of jamming or rusting fast; admitting of the use of common wrenches to fasten or loosen the screws; the exterior adapted for use as a pulley for belts.

All these conditions are fulfilled by the clamp coupling shown in Figs. 15 and 16, except the clause No. 4, relating to flexure. A double shell, connected as shown, becomes very rigid, and the two halves close on the shafts as two semi-circles. There is, however, flexure enough to meet ordinary requirements, because in some experiments made in this country in 1886, where examples of nearly all forms of compression couplings then known were tried, the present one showed the greatest truth and endurance when applied to shafts varying in diameter and sprung out of truth until the couplings failed. Fig. 17 is a perspective view of one of these couplings as it appears when applied on a shaft.

In this review of compression or interchangeable couplings, the purpose has been to select types and analyse the conditions or functions that pertain to them on commercial as well as mechanical grounds. Computations in respect to couplings cover but a limited field, and are confined mainly to proportions for resisting torsional strain and flexure; but these are not in practice the principal facts to be dealt with. Failure comes in most cases from abrasion in the sockets or bearings for the shafts. A small amount of movement takes place because of a bad fit or insufficient gripping power, and abrasion begins, ending with what is not inaptly called "chawing out the hole."

The primary cause of failure is want of alignment, or flexure from other cause, such as the strain of belts or wheels, that causes a slight movement in the sockets. Abrasion begins and goes on in an increasing degree until the end comes.

New inventions have not been reverted to or considered in this section on shaft couplings, because there has really been no recent progress in the art. The first interchangeable couplings made—the plain clamps—were among the best. Those with conical shells and bolts, invented and introduced by Messrs. William Sellers and Co., of Philadelphia, thirty or more years ago, and yet extensively made by this celebrated firm, are among the most complete that have ever been produced, and were the outcome of a successful attempt to reduce shaft fittings to an organised manufacture.



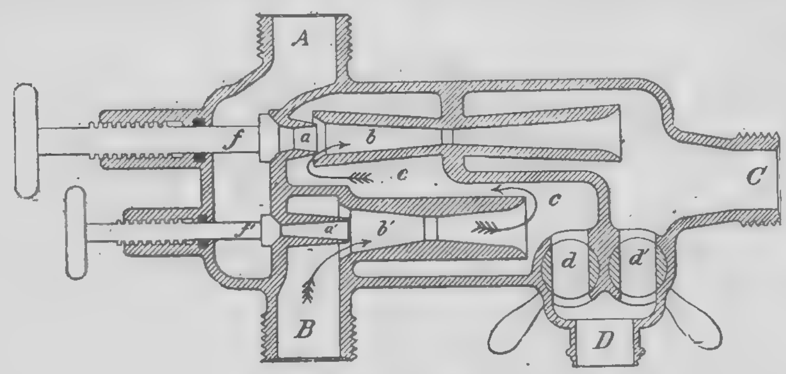
Couplings.—Fig. 17.

The principal difficulty met with in the system has been the mistaken opinion that such couplings were to fit on shafts varying in diameter, which, as at first stated, is a myth. Their object is to permit organised or duplicate manufacture of shaft fittings, and to facilitate putting on and removing the couplings from shafts. Without this there can be no systematic manufacture of the kind, and to compare interchangeable or compression couplings with keyed-on flanges, is to admit a lack of understanding the subject. There is a place for both methods, but not on line shafting as now produced.

Notes on the Steam Injector.

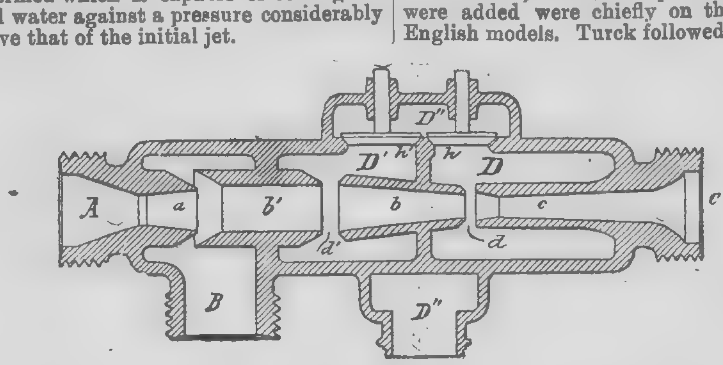
(Continued from page 174.)

A SECTION of this injector is shown in Fig. 4, where *a* and *b* are the tubes of the



Steam Injector.—Fig. 4.

second or forcing set, *a'* and *b'* of the lifting set. An overflow cock is placed beyond each delivery tube for the purpose of starting, as no overflow aperture separates the converging combining tube from the divergent delivery tube. The proportions in which the sets differ are apparent. The first set is primarily an ejector, as the diameter of the steam nozzle is less than that of its delivery tube. In the other set the conditions are reversed, and an injector is formed which is capable of forcing the feed water against a pressure considerably above that of the initial jet.



Steam Injector.—Fig. 5.

A separate valve is provided for each steam nozzle, so that by admitting steam first to *a'*, the feed water is raised and flows from the waste cock *d'*; this is now closed, compelling the water to pass through the smaller combining tube *b'*. The steam nozzle *a* is now opened, and the jet established through the forcing combining tube, aided by the velocity of the entering water due to the pressure produced by the delivery tube of the lifting set; the closing of the final waste cock *d* compels the water to enter the boiler.

The self-adjusting principle of the double-jet injector depends upon the variation of feed pressure when the water entrance to the combining tube is constant. Numerous changes have since been made in the special devices by which the necessary sequence of opening and closing the various steam and waste valves could be obtained. In its modern form this injector is very convenient to operate, and the principle of its construction is incorporated in many of the best-known injectors of the present day.

In tracing the development of the self-adjusting principle, several other improvements of the more elementary forms have necessarily been omitted; these will now be taken up as nearly as possible in the order of their introduction.

In the United States, says a writer in an American contemporary, the self-adjusting injector was so early perfected, and it so largely superseded the original form, that few other improvements were made until the approach of the expiration of Giffard's patents. In England and France, the form of the injector as manufactured by Sharp, Stewart and Co., and H. Flaud et Cie., was modified in various ways; Stewart, Robinson and Gresham brought out several meritorious inventions. Among the most important of these were the adjustable combining tube, which has already been described, and the separation of the lifting apparatus from the ejector proper; in the latter case an injector, whose only function was to raise the feed water, was connected with the overflow aperture of the combining tube, and by its aid the injector could be started with great facility. In 1863 the same firm patented an arrangement by which the injector was placed below the level of the water in the tank of a locomotive; the waste pipe from the overflow extended up into the cab above the water level, and any waste from the injector could be readily seen and corrected; further, the drip pipe was connected with the suction, and loss of feed water from any cause prevented.

In France, the few improvements that were added were chiefly on the line of English models. Turck followed Gresham in the use of a stationary steam nozzle, and in addition applied an enveloping nozzle, enclosing an air space, in order to prevent transmission of heat from the steam to the surrounding feed water. Cuau brought out an injector in which all the tubes were fixed, and so proportioned as to permit the use of water of very high temperature; no lifting spindle was provided, but the feed water was raised by an auxiliary ejector. Bouvret, Polonceau,

and Delpeche followed with comparatively unimportant modifications, although all have lent their names to styles used upon railroads in France.

As no patent was allowed Giffard in Austria and Germany, his injector was manufactured by unlicensed parties soon after its introduction in France, and much original investigation was started. Schau discovered the advantage of the divergent steam nozzle in 1869, by which the expansion of the steam is utilised to better advantage than with the convergent shape. Haswell, Körting, Pradel, and Krauss introduced special changes, many of which are still in service. Körting, whose invention of the double-jet injector has already had special consideration, was granted a patent in 1872 for drawing exhaust steam from the cylinder into the injector, by which the temperature of the water delivered to the boiler was considerably raised; an opening was made in the combining tube at a point where a strong suction was produced by the condensation of the motive jet: the inventor states in his specifications that the injector could be used with live steam alone, and that the supplementary overflow enabled it to start very easily. Friedman, in 1879, patented an improved fixed nozzle injector, and in the form in which he placed it upon the market used a supplementary opening in the combining tube for the entrance of an additional supply of feed water; this system possessed a number of advantages, and after undergoing subsequent modification is now extensively used both in Germany and the United States.

In England, in 1877, Hamer Metcalf and Davies obtained a patent for an injector in which there was a very large steam nozzle, and a combining tube with a hinged section extending nearly its full length; these modifications were made for the purpose of using exhaust steam for the actuating jet, and the injector was enabled to feed boilers carrying as high as 80lb. pressure; the tubes were well designed, and showed much ingenuity in their construction.

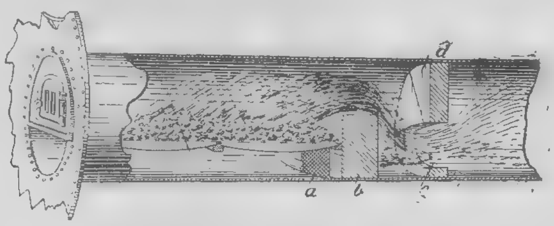
Returning to American improvements, we find Garner C. Williams, of Ellenville, N.Y., made in 1880 application for a patent for the first self-starting injector; it was very ingeniously constructed, but seems never to have appeared upon the market. John Loftus, of Albany, N. Y., followed, in 1881, with a simpler device, shown in Fig. 5, which differed from all previous forms by the insertion of a cylindrical suction or draught tube b', between the steam nozzle and the combining tube. This obviated the necessity for a special priming device, as the opening of an ordinary globe valve in the steam pipe would produce a vacuum in the water branch sufficient for all ordinary lifts. Checks valves h h' were placed on the separate overflow chambers D, D', so that the condition of the jet while crossing the starting overflow d was independent of and uninfluenced by its condition at the upper or supplemental overflow d'. Bancroft, Gresham, Penberthy, Desmond, Derby, and others altered and improved the arrangement of the valves and tubes of the restarting injector and increased the efficiency of its performance.

(To be continued.)

The "Smoke Annihilator."

THE unremitting attention given by inventors to the devising of apparatus for the prevention of smoke in steam-boiler furnaces proves very conclusively that the problem is one which has yet to be fully solved. Probably upon no other subject in steam engineering has so much time and money been expended; but it is nevertheless true that no great improvement has been effected during recent years in this direction, notwithstanding the claims of many sanguine inventors and speculative syndicates.

One of the best methods for preventing smoke is to employ a reheating device of some kind behind the bridge in order to promote a secondary combustion of the carbon monoxide and volatile hydrocarbons. In the arrangement shown herewith, known as the "Smoke Annihilator," this principle has been adopted by fixing a drop arch d of fireclay in the furnace tube, about 15in. behind the usual bridge. This drop arch, which becomes incandescent, is of such a shape as to cause the gases to be deflected downward as indicated, these being met by a current of air, which is admitted through the lower part of the bridge b. We may say that this secondary air supply is regulated by causing it to pass through iron gauze, so that when once the correct mesh of gauze has been found, no alteration or regulation of the air supply is needed. The screen of gauze is arranged so as to allow of its being quickly removed if required for cleaning. The action of the arrangement will now be readily perceived. The air entering through the lower part of the bridge meets with the deflected current of gases, smoke particles, etc., and the mixture is ignited by contact with the incandescent surface of the drop arch d. We recently inspected this arrangement in operation at the mills of Messrs. Thos. Mellor and Sons Limited, Ashton-



Smoke Annihilator.

under-Lyne. In this case, out of a battery of four Lancashire boilers, three had been fitted with the annihilator, and it was therefore possible to make a comparative test by first firing the one unfitted furnace and then the three fitted with the annihilator. We may say that it was shown very conclusively that less smoke was made by the three boilers than by the unfitted one, thus amply demonstrating the efficiency of the device.

We should state that the "Smoke Annihilator" was invented by Mr. B. H. Thwaite, C.E., in 1891, since when it has been perfected by the present proprietor, Mr. D. H. Noar, 11, Chapel-walks, Cross-street, Manchester.

As will be seen, the apparatus has the very important advantage of simplicity, while it can be fixed in a few hours by an ordinary bricksetter. Further, no drilling of the boiler plates or alteration to the firebars is required, and no forced draught, or fragile bridge liable to be damaged by the stoker, is employed. No tests of the economy effected have yet been made, but nevertheless sufficient has been shown to prove that this item will form not the least advantageous feature of the arrangement.

Machine Construction.

THE CONSTRUCTION OF MACHINE ELEMENTS.

(Continued from page 224.)

THE figures show clearly the various stresses at the respective portions of the crank, and throw light upon the manner in which breakages occur.

If both crankarms are normal to the axis, the solution is greatly simplified, and the diagram assumes the form given in Fig. 471. In this we have again A B C D E F G H as the skeleton, and at A a torsion couple whose moment is equal to P R.

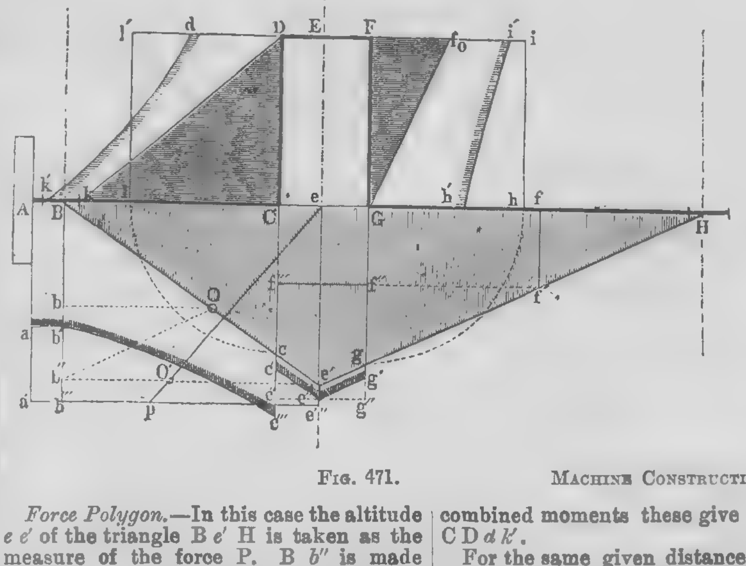
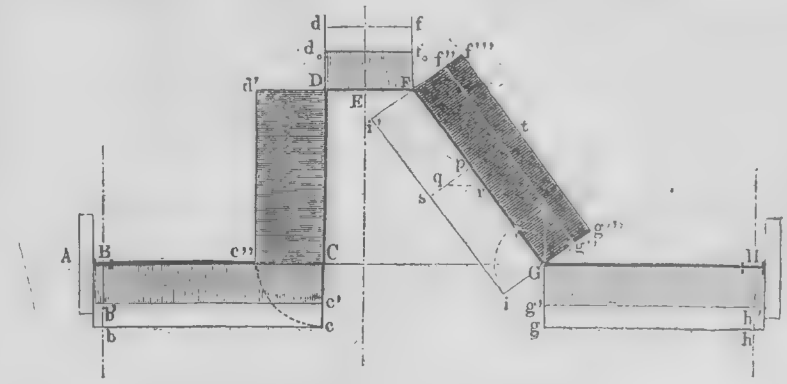


Fig. 471. Machine Construction.

Force Polygon.—In this case the altitude $e\,e'$ of the triangle B e' H is taken as the measure of the force P. B b'' is made equal to $e\,e'$, b'' O drawn parallel to e' H, and O b made normal to B b'', thus giving $b\,b$ as the force P_3 at H, b B that at B, and O b is the corresponding pole distance.

Axle Shank H G.—This is only subjected to bending, and the surface of moments is H G g.

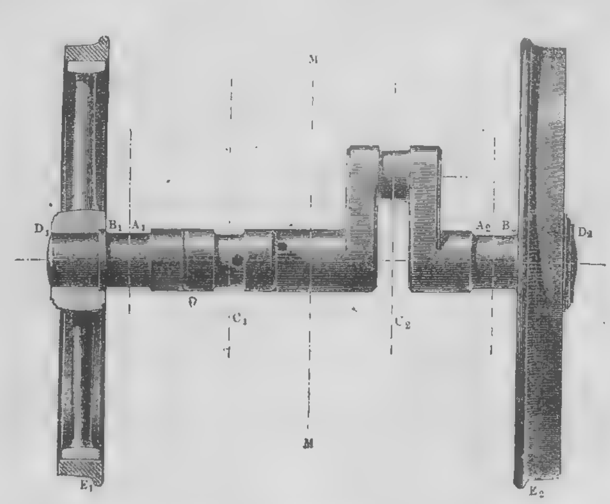
Axle Shank A B C.—This is subjected to bending, as indicated by the triangle B C c, and also to torsion by a moment P R. Make e' O' parallel to C B and equal to the pole distance b O, draw e''' p parallel to e' O' and equal in length to E e = R, then $e\,e'''$ is the desired twisting moment, giving for A C the torsion rectangle whose altitude



Machine Construction.—Fig. 472.

A' a' = B b''' = $e\,e'''$. The combination of bending and torsion moments gives the moment surface A B C c''' b' a.

Crankpin D E F.—This is subjected to bending according to the surface of moments C G g c, and to torsion by the force P_3 at H, with a lever arm R = C D = H f, and a moment $f\,f'$ = G f'' = C t'''. By combining the twisting and bending moments the surface C G g' e'' c' is obtained, and for cylindrical crankpins the rectangle of a height G g'' = C c'' = $e\,e''$ is to be substituted for the irregular outline.



Machine Construction.—Fig. 473.

Crankarm F G.—This is subjected to bending by the force P_3 acting at G. The surface of moments is G F f_0, the angle at G being equal to f H f'; it is subject to torsion by the same force acting with a lever arm H G, giving a moment G g = G h = F i. The combination of twisting and bending moments gives the surface F G h' i'.

Crankarm C D.—Here we have bending with the force P and an already known moment $e\,e'''$ = C k at C. Twisting is due to the moment C c = C l = D l'. For the combined moments these give the surface C D d k'.

For the same given distances of E from B and H the torsion stresses on the crankarms are greater for arms normal to the axis than for inclined arms, so that in the former case heavier arms are required. The torsion in the crankarms grows less and less the nearer the points C and G approach B and H, which is a point to be considered in the interest of economy of material. It is also to be noted that the total length of crank axle F G H or D C B is less for inclined arms than for right-angled cranks.

In many cases a crank axle is so situated that it is subjected to torsion at either one end or the other. In such cases the diagram should be constructed for both sets of conditions, and laid upon each other, the greater value in all cases being taken. Of course, care must be taken to use the same pole distance and same scale for measuring forces in both cases. An example of such a case is found in the paddle engines made by Penn, with oscillating cylinders, the air pump being worked from the middle of the crankpin. The conditions in this case are somewhat different from the preceding, and may be examined with the help of the diagram Fig. 472.

Here we have the skeleton A B C D E F G H, and not taking into account the force at E, the force couple gives by means of the cord and force polygon the moment values B b = C c = G g = H h, from which the following results are obtained:

Axle Shank A B C.—Pure torsion, which, converted into an equivalent bending moment, gives B b' = C c' = $\frac{5}{8}$ B b (see IV., § 16, when $M_b = O$).

Axle Shank G H.—This is the same as the preceding, and H h' = G g' = C c'.

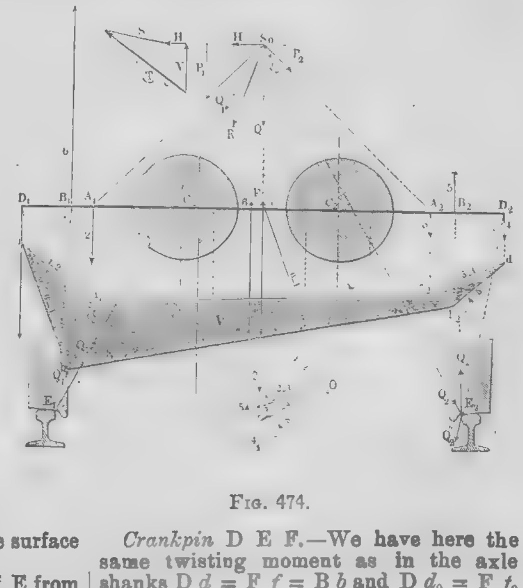


Fig. 474.

Crankpin D E F.—We have here the same twisting moment as in the axle shanks D d = F f = B b and D d_0 = F f_0 = B b'.

Crankarm C D.—We have in this portion a bending moment of the magnitude C c'' = D d' = C c, of which the plane

stands normal to the plane of the surface of the crankarm. The surface of moments is in this case equal to a rectangle of the height B b = C c.

Crankarm F G.—In this case we have both torsion and bending. The couple is decomposed at G into two parts, one acting normal to the axis of the crankarm, and the other in the direction of the arm. The first gives the torsion rectangle G F $f'' g''$, the latter the bending rectangle F G $i\ i'$, which combined give the moment surface F G $g'''\ f'''$, in which we again have $p\ q = \frac{2}{3}$ G i, $p\ r = \frac{2}{3}$ G g'', $p\ t$ = G $g'' = q\ s - q\ r$.

Thus far we have proceeded as though there were no force acting at E. When such exists, however, first determine the bending and twisting moments as shown in Fig. 472, add or subtract, according to direction, the twisting moments, taking into account the position of the planes of bending action, and finally combine the bending and twisting moments so found, according to the method of Case IV., § 16. The amount of work which this investigation requires of the drawing room of any machine shop is small compared with the importance of a thorough determination of all the stresses which act upon such a piece of work as a crankshaft forging.

§ 172.

MULTIPLE CRANKSHAFTS, LOCOMOTIVE AXLES.

One of the most important forms of crank axles made of wrought iron or steel is that used for locomotive engines. As an example of this subject, the crank axle for an inside-connected locomotive is given in Fig. 473. In drawing the diagram of moments it is necessary to take into account the diameter of the driving wheels, as will be shown in Fig. 474. C_1 and C_2 are centres of the steam cylinders, A_1 and A_2 are the journals, and $B_1\ D_1$ and $B_2\ D_2$ are the hubs of the respective driving wheels. The cranks at C_1 and C_2 are placed at right angles with each other, taking the position which the axle shows in Fig. 473. An inspection of the figure shows three distinct loads acting upon the axle:—(1) The pressure in the vertical plane due to the weight of the locomotive and to the lateral action upon the wheel flanges; (2) the horizontal pressure of the piston against the crank C_2 opposed by a corresponding adhesion at the circumference of the driving wheels; (3) the oblique pressure of the connecting rod acting upon the crank C_1. Other small pressures, such as those due to the eccentrics, etc., may be neglected.

Forces and Moments in the Vertical Plane (Fig. 474).—From the point S_0 of the height of the centre of gravity of the locomotive lay off the force Q, to represent that portion of the weight which is borne by the axle under consideration. The oscillations and action of centrifugal force upon curves also produce a horizontal force H, which may be taken as equal to 0·4Q. The resultant R of the two forces Q and H is the load upon the axle. This may be decomposed into the pressures P_1 and P_2 upon the journal at A_1 and A_2, and into the pressures Q_1 and Q_2 upon the wheels at E_1 and E_2, which pressures, with their reactions, produce the stresses on the axle. The forces Q_1 and Q_2 can be decomposed into two others referred to the wheel hubs B_1D_1 and B_2D_2. This gives six vertical pressures acting to bend the axle—viz., 1, 2, 3 and 4 acting downward at D_1, A_1, A_2, and D_2, and 5 and 6 acting upward at B_2 and B_1. From these forces, by choosing any desired pole distance, the force polygon F, 4, O may be constructed, and also the cord polygon or surface of moments $d_1\ a_1\ a_2\ d_2\ b_2\ b_1$, and this surface gives by its ordinates the proportional bending moments in the vertical plane for each point in the axle; this entire surface is designated by the letter V.

(*To be continued.*)

New Swindon Junior Engineering Society.

THE first of the summer excursions of this society took place on Saturday, June 10, when, through the kindness of P. K. Stothert, Esq., and H. G. Massingham, Esq., the respective managing directors, a fair number of the members journeyed to Bath to visit the engineering works of Messrs. Stothert and Pitt Limited, and also the City of Bath Electric-lighting and Engineering Works. The first-named visit, in the morning, was rendered particularly interesting from the fact that one of the firm's well-known Titan cranes was approaching completion. This crane is constructed to lift 25 tons at 75ft. radius, and is designed in 30ft. lengths for shipment to Pernambuco, in Brazil. Two traversing cranes for Southampton Docks and Dover Harbour, with other cranes in course of construction, attracted attention. The extensive use of mechanical stokers in the boiler-house was noted, and photographs of cranes constructed by the firm, kindly produced by Mr. Pitt, were inspected.

In the evening the party visited the Electric-lighting Works, their number having been greatly augmented by members who had joined them during the afternoon. Eight Brush vertical compound engines form the motive power in this interesting station, four for the incandescent-lighting installation, coupled with continuous ropes to Mordey alternators, and four for the arc-lighting installation, coupled with link belting to Thomson-Houston machines. Only half of the machines are in use at one time, and there being seven miles of mains and 40 miles of cable, the precaution in thus having duplicates would seem necessary. The visitors were conducted over the works by the managing engineer, Mr. G. F. Metzger, whose kind and instructive explanation of the machinery and system they greatly appreciated. A meeting will be held shortly to discuss the information gained, when short papers will be read by Messrs. W. L. Holt and H. G. Cotsworth.

The Design and Construction of Stationary Engines.—LVI.

THE number of arms, as in small wheels, is fixed upon arbitrarily. The following are the usual numbers adopted by most makers:—Wheels from 2ft 6in. to 7ft. diameter, six arms; from 8ft. to 16ft. diameter, eight arms. In the case of rope fly-wheels of large diameter, the rims are usually made in 8, 10, 12, 16, 24, and sometimes 28 segments. Wheels under 8ft. diameter are generally cast in one piece, and in halves if over 8ft. up to 12ft diameter; from 13ft. to 20ft. diameter they may be made in six to eight segments; from 20ft. to 24ft. in 10 segments; and from 26ft. up to 32ft., 12 arms. 35ft. wheels are made in 16 segments, with corresponding number of arms. Very heavy broad wheels, with a large number of grooves, are commonly made with two bosses and two sets of arms.

The largest rope fly-wheel is probably 35ft. diameter, grooved for 40 1⅝in. ropes. The heaviest rope wheel is probably that made some years ago by Messrs. Hick, Hargreaves and Co., of Bolton, for the engines of the Mannockjee Petit Mills, Bombay, of 4000H.P. This wheel is 30ft. diameter, 15ft. wide on the face, grooved for 67 1⅝in. ropes, and it weighs 140 tons.

Diameter of Arms.—For built-up fly-wheels, with round hollow arms, the following empirical rules may be employed as approximately representing modern practice:—

$$\text{Diameter of boss in feet} = \frac{\text{Diameter of wheel in feet}}{4}$$

$$\text{Diameter of arms at boss in inches} = \frac{\text{Diameter of wheel in inches}}{25 \text{ to } 30}$$

Thickness of metal of arm in inches = diameter of arm at boss in inches × 0·135. Length of arm in boss = 2¼ to 2½ times largest diameter.

It is the general practice to lag the sides of large wheels from boss to rim either with wood or sheet iron or steel. This is done for the purpose of reducing the churning action of the revolving arms on the air, and thereby reducing the external resistance to the engine caused thereby.

Weight of Fly-wheels.—Perhaps no part of the steam engine has received less consideration than the proper weight of fly-wheel suitable for a given engine, and this probably arises from the fact that the formation of the fly-wheel is but imperfectly understood by many engineers and engine builders.

As already pointed out, the fly-wheel is merely a reservoir of energy, and its main function is to ensure regularity of turning effort. The degree of regularity, or the steadiness of running desired, depends on several circumstances. For cotton mills, weaving sheds, and electric-light purposes very steady turning is essential, and this is secured to a great extent by providing a fly-wheel of the proper size and weight.

The weight required will depend on the diameter and speed of rotation. Hence high-speed engines may have their fly-wheels comparatively light and small in diameter.

The rules proposed for determining the proper weights of fly-wheels are very various, and but few are satisfactory. The following are a few of these rules:—

(1.) Weight of rim in lb. = area of cylinder × average pressure × stroke in feet.

(2.) Weight of rim in cwt. $= 1200 \frac{H \times x}{R^2 \times N^2}$

Where H = indicated horse-power, x = degree of irregularity, N = number of revolutions per minute, R = radius of wheel, to which must be added 15 per cent. and upwards for engines working expansively.

(3.) $W = \frac{18{,}840\ U}{R^2 \times N^2}$. W = weight of wheel in lb., U = the whole work done per revolution, F = fluctuation of energy, N = number of revolutions per minute, $\frac{N}{60}$ = number of revolutions per second, f = number of revolutions by which the speed may vary—that is, the difference between the least and greatest number of revolutions per minute, R = mean radius of rim of wheel in feet, $g = 32{\cdot}2$ = acceleration of gravity. Then, in order that the number of revolutions may not vary more than f, we must have

$$\frac{W}{2g}\left[\left(\frac{N + \frac{f}{2}}{60}\right)^2 - \left(\frac{N - \frac{f}{2}}{60}\right)^2\right](2\pi R)^2 = F.$$

That is,

$$\frac{\pi^2\ R^2\ W\ N\ f}{28{,}980} = F. \quad \therefore \text{ or } W = \frac{2940\ F}{R^2\ N\ f}$$

nearly.

In order to use this formula, we require to know the ratio that F bears to U, the whole work per revolution; and also what variation f may be allowed.

The ratio $\frac{f}{N}$ is usually from $\frac{1}{30}$ to $\frac{1}{60}$, the latter value being used when very regular rotation is desired—$\frac{1}{40}$ in ordinary cases. The ratio $\frac{F}{U}$ has been calculated by Morin for different classes of engines and proportions of connecting rod as follows:—

TABLE XXXV.

Non-expansive. Ratio of Crank to Con. Rod.	Non-expansive. $\frac{F}{U}$	Expansive Non-condensing, when Ratio of Crank to Con Rod = 5. Cut-off $\frac{1}{r}$ of the Stroke. $r : \frac{F}{U}$	Expansive Condensing, when Ratio of Crank to Con. Rod = 5. Cut-off $\frac{1}{r}$ of the Stroke. $r : \frac{F}{U}$
3	0·105	2 : 0·160	3 : 0·163
4	0·118	3 : 0·186	4 : 0·173
5	0·125	4 : 0·209	5 : 0·178
6	0·132	5 : 0·232	6 : 0·184
—	—	—	7 : 0·189
—	—	—	8 : 0·191

For double-cylinder engines the ratios are almost equal to those of single-cylinder engines, working without expansion.

To find the fluctuation of energy during one revolution of the crank by means of Table XXXV. multiply the ratio there given by the whole work done by the steam during one revolution of the crank.

For expansive non-condensing engines, cutting off at half-stroke, W is given by formula (3) above. Where H = actual horse-power, $U = \frac{33{,}000\ H}{N}$

The following rule for the weight of fly-wheels appeared in the "American Machinist":—

$$W = \frac{A \times P \times S \times C \times C' \times g}{F \times 2240}$$

where W = weight of wheel in tons, A = area of cylinder in square inches, P = boiler pressure, S = stroke in feet, C = 0·1 to 0·22, C′ = 20 to 60 coefficient of fluctuation, $g = 32{\cdot}2$, F = square of velocity in feet per second of the centre of gyration of wheel, R = number of revolutions per minute, D = diameter of centre of gyration, which may be taken as approximately equal to diameter of inside of rim of wheel.

The weight is inversely as the square of the velocity, and directly as the coefficient of fluctuation.

Another formula, based on that proposed by the Buckeye Engine Company, is:—$W = \frac{4{,}000{,}000}{D} \div R^2$, where W = weight of rim of wheel in lb. per I.H.P., D = diameter of wheel in feet, R = number of revolutions per minute, I.H.P. = indicated horse-power.

Rankine's rule for fly-wheels is as follows:—

$$W = \frac{\text{I.H.P.} \times 65{,}800{,}000}{V \times D^2 \times N^3} \quad \ldots\ldots\ (1)$$

$$W = \frac{APmS \times 4000}{V \times D^2 \times N^3} \quad \ldots\ldots\ (2)$$

Where W = weight of rim in cwt., I.H.P. = indicated horse-power, APmS = area of cylinder in inches × mean pressure in lb. × stroke in feet, V = variation of speed per cent. (the value of V for portable engines is 4 per cent., ordinary engines 3 per cent., for good governing 1½ to 2 per cent.). N = number of revolutions per minute.

Formulæ (1) and (2) apply to non-condensing engines cutting off at ⅓ to ¼ stroke; for ordinary non-automatic expansive engines the weight may be ⅕ less.

The following formula is one used by a large firm of engineers in the North of England:—

$$W = \frac{2g \times FP}{V^2}$$

Where W = weight of rim in lb., g = 32·2., V = velocity of rim in feet per second, F P = foot-pounds of work done on piston = area of cylinder in square inches × average pressure in lb. × distance in feet travelled by piston during X revolutions, X = number of revolutions performed by engine with full load on, after steam is cut off. (X = 1·5 to 2 revolutions for pumping engines; X = 2 to 3 revolutions for sugar-mill engines; X = 4 to 8 revolutions for cotton-mill and similar engines.)

Some engineers, again, build their fly-wheels such that the accumulated work stored up in the wheel = three times the work done in the cylinder in one revolution for single condensing and tandem compound engines working on to one crank, and 2½ times for side-by-side compound engines with cranks at right angles.

In the case of engines having rope fly-wheels, the difficulty is to keep the weight down, as generally, owing to their great size and width, to give the high speed required and number of ropes, the weight of such wheels comes out in practice much heavier than is actually required for good governing. The accumulated work stored up in such wheels varies from 3½ times to 7 times the work done in the cylinder per revolution.

From a number of cases in actual practice the writer finds the weight of rope fly-wheels is approximately from 85 to 125lb. per indicated horse-power for compound engines with cranks at right angles, and 150lb. for compound tandem engines working on to one crank.

(*To be continued.*)

Shipbuilding Notes.

On the 14th inst. Messrs. Wm. Gray and Co. Limited launched a steel screw steamer. The triple-expansion engines, built by Messrs. Blair and Co. Limited, of Stockton, have cylinders 22, 36, and 59in. diameter by 39in. stroke. The dimensions are:—Length over all, 297ft.; breadth, 39ft.; depth, 19ft. 2½in.

On the 15th inst. Messrs. T. Turnbull and Son, Whitby, launched a new steel screw steamer. Her length over all is 321ft. 9in.; length between perpendiculars, 311ft.; breadth (extreme), 40ft. 6in.; depth to top of flooring, 21ft. 11in. Her engines are by Messrs. Blair and Co., Stockton, and of 236H.P. Her dead-weight carrying capacity is about 4200 tons.

On the 15th inst. Messrs. S. M'Knight, shipbuilders, Ayr, launched from their yard a steel screw steamer. The engines will be supplied by Messrs. Muir and Houston, engineers, Glasgow. The principal dimensions are:—Length, between perpendiculars, 165ft.; breadth, 26ft.; depth, 13½ft. Cylinders, 23 and 46in. diameter by 33in. stroke; boiler, 15ft. diameter by 10ft. 6in. long, 120lb. W.P.

Messrs. Scott and Co., Greenock, launched on the 14th inst. a steel passenger steamer of 200 tons register, for service on the river Senegal. The dimensions are:—Length, 145ft.; breadth, 22ft.; depth, 8ft. She is to be supplied with compound-diagonal engines of 400I.H.P., with a working pressure of 100lb., the cylinders being 18 and 38in. in diameter respectively, with a piston stroke of 42in.

Messrs. Wigham Richardson and Co. launched on the 15th inst., from their Neptune Shipyard, Newcastle-on-Tyne, a steel screw steamer which they are building to the order of the Royal Hungarian Sea Navigation Company. The vessel is 285ft. in length and 38ft. beam. The engines, which, with the boilers, are also being constructed by Messrs. Wigham Richardson and Co., are of the triple-expansion type.

A screw steamer was launched on the 14th inst. from the yard of Messrs. John Readhead and Sons, South Shields. The dimensions are:—Length, 280ft.; breadth, 38ft.; depth (moulded), 22ft. The engines, which have also been built by Messrs. John Readhead and Sons, are on the triple-expansion principle, having cylinders 24, 35, and 57in. diameter by 39in. stroke. Steam will be supplied by two steel boilers working at a pressure of 160lb. to the square inch.

There was launched on the 15th inst., from the yard of Messrs. William Doxford and Sons Limited, of Sunderland, a whaleback steamer. This is the first vessel built in Great Britain of the American whaleback type, under the "McDougall" patents. Her principal dimensions are:—320ft. by 28ft. 2in. by 26ft., and she is intended to carry about 3500 tons. She is fitted with triple-expansion engines by Messrs. Doxford, and has cylinders 23, 37, and 60in. in diameter by 42in. stroke, and large single-ended boiler.

Messrs. E. Green and Son's Fuel Economiser Works.

On Saturday last, a party of engineers, under the auspices of the Ashton-under-Lyne Society of Engineers (James Watt Lodge), and which included members from Oldham, Rochdale, Stalybridge, etc., paid a visit to the extensive fuel economiser works of Messrs. E. Green and Son Limited, Wakefield, by the special invitation of that firm. The party, which numbered upwards of 200, left Victoria Station, Manchester, at 2-50 by special train, and arrived at Wakefield at 4-30. They were received by Messrs. Pearson, Parker, Goldthorp, and others, who, in the absence of Sir Edward and Mr. Frank Green—now in the United States in connection with the establishment of new works there,—extended a cordial welcome to the visitors. The party divided into sections and inspected the various operations involved in the manufacture of high-class fuel economisers. The works are situated in close proximity to the Lancashire and Yorkshire and Great Northern railways, and are also near the river Aire; the number of hands employed is about 300. Commencing with the foundry, the visitors first inspected the cupolas and moulding shops. Especial interest was taken in the method of moulding the economiser pipes, which are cast vertically in circular moulding pits. Each pit contains twenty-eight moulding boxes arranged in a circle, and manipulated by means of an overhead crane. After being rammed up, the moulds are dried by passing a current of hot air through them. By this method the moulds are thoroughly dried in from five to seven minutes. The plate-moulding arrangements for making the top and bottom boxes, scrapers, etc., were next inspected, after which a visit was paid to the machine shop, where several multiple boring machines, as well as pipe-turning and planing machines, and other specially-arranged tools were seen in operation. In the testing department some sections of an economiser were being subjected to a pressure of 325lb. per square inch without the slightest leakage, although the joints are plain metal to metal, without packing of any kind. A section of a Green's economiser which had been in constant use for over seven years was next tested to destruction, for the edification of the visitors. Failure took place by fracture of the top box at a pressure of over 1000lb. per square inch, and therefore bore excellent testimony to the high-class material used and the excellence of the workmanship bestowed by Messrs. Green on the manufacture of their speciality. The party afterwards adjourned to the Bull Hotel, where a substantial repast was provided, after which a cordial vote of thanks was accorded to the firm of Messrs. Green for their kind invitation. Various experienced gentlemen afterwards spoke, testifying to the good results obtained by Messrs. Green's machines. After some remarks by Mr. Mellor, of Oldham, referring to the effect of the water in economisers under high pressures, Mr. Ed. Ingham, of Oldham, made a few remarks, in the course of which he expressed his great admiration of the splendid facilities which Messrs. Green possessed for the production of accurate work. Messrs. Boardman and Robinson, the treasurer and secretary of the James Watt Lodge, also expressed their admiration of the manner in which the representatives of the firm had entertained the party. After some remarks by Mr. Goldthorp, Mr. Parker read a letter from Mr. G. E. Tennant, Messrs. Green's head manager, expressing regret at his inability to attend. Mr. Balkwell, the foreman of the fitting department, gave some interesting data with regard to the bursting stress of the new pattern high-pressure economisers. This he stated to be 1760lb. per square inch for new pipes. The proceedings terminated with a vote of thanks to Mr. Parker, who occupied the chair in the unavoidable absence of Mr. G. E. Tennant.

The Peninsular and Oriental steamer "Himalaya" has just made the fastest passage on record to Australia, having arrived at Adelaide at 3 a.m. on the 15th inst., with the London mails of May 19. This gives a mail transit between London and Australia of twenty-six days six hours, which is half-a-day shorter than any previous delivery, and proves the superiority of the Suez route over any other.

The French Government Commission which has been considering the best place to build a large lighthouse, for which Mme. Davoust d'Ekmühl several years ago left a large sum of money, having recommended Penmarch at Finisterre, the work will soon be taken in hand. The lighthouse will have a height of 210ft., and will be lighted by means of electricity, so that it can be seen at a distance of about twenty miles. It will be built entirely of granite, and will be fitted with a fog-signalling appliance.

The Modern Travelling Crane.*

Before proceeding to read the brief paper which I have prepared for this evening, I think, perhaps, that a few words by way of explanation of its motive may not be inappropriate.

It would seem almost superfluous to tell an audience, composed so largely of gentlemen who are engaged in mechanical pursuits and familiar with mechanical devices, that the problem which has confronted the modern manufacturer in his effort to produce larger machines of various kinds than heretofore—heavier locomotives, bigger bridges, more powerful warships, and the thousands of other gigantic structures demanded in this era of mechanical progress—has been not so much a question of the enlargement of factory buildings, or of increasing the melting capacity of furnaces, or of adding to the number of employés, but it has been mainly a question of obtaining adequate facilities for handling quickly and economically the enormously heavy materials composing such great structures; and I do not think it is an exaggeration to say that the limit of capacity of any establishment for such large work is determined by its facilities for handling its raw material with economy and despatch.

If you are given unlimited time and an unlimited amount of labour you can accomplish great results with exceedingly simple and crude appliances, but the more you try to economise time and labour in the performance of mechanical work, the more intelligence and skill you must crystallise into the forms of auxiliary machinery.

We all know that the simple dropping of water will, in time, wear away the hardest stone; but the little rock drill, which performs its work in a few moments, represents a high degree of mechanical efficiency.

The Great Pyramid at Gizeh, near Cairo, erected more than 4000 years ago (or, according to the generally-accepted chronological records, more than six centuries before the time of Moses), stands to-day the largest structure of any kind ever erected by the hand of man. Composed of huge blocks of hewn stone, covering a space of more than 13 acres at its base, equivalent to more than four squares of buildings in this city, it rises to a height of more than 450ft., or nearly twice the height of the tallest church spire in Philadelphia. The weight of this great mass has been computed at more than 5,000,000 tons.

Modern writers are fond of pointing to these facts as evidences that the ancients possessed mechanical appliances for handling heavy materials far surpassing those of the present time, but, until the two important factors of time and of labour are more clearly stated, I think we are justified in withholding our assent to such a broad inference. What did these autocratic rulers of Egypt care whether 100, or 1000, or 100,000 slaves were employed for a year, or a decade, or a century in the construction of this great monument? They were building for all time, and had no thought of economy either of time or of labour in the construction.

The Greek historian Herodotus, who visited this pyramid about 400 years before the Christian era, tells us that it was regarded in his day as the most stupendous and most venerable monument of antiquity, and he further states that certain inscriptions on stone tablets recorded the fact that 100,000 men were engaged for 30 years in its construction. I have little doubt that if such a problem should be presented to our modern engineers it could be solved with the expenditure of a fraction of the time and labour represented in this Great Pyramid.

Coming now to a more modern illustration for the purpose of our comparison, I am reminded of an amusing story related of the late Matthias W. Baldwin, in the early days of his locomotive building in this city. The incident occurred, I believe, about the year 1840. One morning Mr. Baldwin received in his mail an order for twenty locomotives, coupled with the condition that they must be completed and ready for delivery within one year of the date of signing the contract. Mr. Baldwin declared that such a proviso with such a large order was preposterous, and that it would be impossible to complete the contract in the time specified. On looking over the illustrated history of the Baldwin Locomotive Works, I find that the total output for the year 1840 was nine engines, and it was not until thirty years had elapsed that the first 1000 engines were completed.

The present capacity of the Baldwin Locomotive Works is about 1000 engines a year. To what shall we attribute this enormous expansion? The enlargement of the buildings and the increased number of employés are important factors, but more men and larger buildings could have been obtained in former years, while the various modern appliances for expediting work were not then invented, by the aid of which the "impossibilities" of 1840 have become the ordinary realities of to-day.

For a final comparison I would select an illustration in which you may all have a share. If I should ask any mechanic present to-night to close his eyes for a moment and form a mental picture of the appearance of the machine shop in which he acquired his technical education and to describe its most prominent features, he would probably say something similar to this:—

"I see a long, low, dingy building, with small windows and little semi-opaque panes of glass admitting feeble illumination; on the floor I see a miscellaneous assortment of machine tools—lathes, planers, boring mills, etc.—crowded together in some places, while elsewhere there are large vacant spaces. I see a number of masts or columns erected at intervals upon the floor, pivoted to foundation plates, and in many instances to the rafters. Attached to these masts are heavy swing arms, strongly braced, carrying chains and hoisting tackle. A large casting is about to be transported from one end of the shop to the other; the chains are attached, the object is raised a few feet from the floor, it is swung round until the arm intersects the circle of the swing of the neighbouring apparatus. It is now deposited upon a vacant space on the floor, again raised, again swung round and re-deposited, and so it is moved step by step until it reaches its final resting-place. Not only is a great deal of time lost in these operations, but valuable floor space also is permanently given up to the hoisting appliances and temporary resting-places for the castings."

(To be continued.)

* A paper by Alexander E. Outerbridge, jun., read before the Franklin Institute of Philadelphia.

Some Experiments on the Effects of Punching Steel Plates.†

The author's experiments were undertaken at the Case School of Applied Science, and their object was to determine (1) the ultimate resistance to shearing for different forms of punches, and the relation of stress to sinking, and (2) the effect of punching on the elastic limit and ultimate tensile strength.

A Riehle screw-power testing machine was used, with ordinary round and square, flat-ended, projecting centre, double step, and spiral punches. The tests were on Otis steel boiler plates, 10in. long, $2\frac{1}{2}$in. wide, and $\frac{1}{4}$in. thick, stamped 60,000lb. tensile strength.

In carrying out the trials, one plate was reduced in width for several inches near the centre, and broken by tension in the testing machine, its modulus of elasticity and ultimate strength being carefully noted, as also the contraction of area at fracture. A second piece was cut apart in double shear by a straight die, the ultimate shearing stress and relation of stress to distortion being observed.

Each of the remaining pieces was punched at the centre of its width and length, readings being taken at intervals of each 2000lb. of load until the punch came through.

A graphic diagram of the relation of sinking to the load applied is given, in respect of which the author draws especial attention to the entire absence of any yielding or breaking-down point, the curves, after occasional irregular commencements, due possibly to settlement of the specimen, rising steadily to the maximum.

The results are given in three tables, the first referring to the load and unit stress, with single tests of all the punches; the second to similar details, averaged from several tests with each of four shapes of punch; and the third dealing with the elastic limit, breaking stress, contracted area, and elongation of hole of the punched plates.

The first two tables show that, with the notable exception of the spiral punch, there is little difference in the ultimate unit stress with the other different-shaped punches, and that the claim made for the projecting centre punch of reducing resistance to punching by stretching the metal is not borne out. In the case, however, of the spiral punch, a saving is shown of 23 per cent., the average unit-stress being reduced from 50,000lb, to 38,500lb.

The tension-breaking tests tabulated in Table III. vary no more with the different kinds of punch than might be expected from various samples of the same plate. Their average shows 7·5 per cent. less ultimate strength, 5 per cent. increase in elastic limit, and 30 per cent. less contraction of area than in the drilled plate. Where the spiral punch was used, however, the ultimate strength was only 3 per cent. less, and contraction of area only 20 per cent. less than with the drilled plate.

The author points out that variation in clearance between punch and die may be said to always affect the results, though no very marked differences are shown where the clearance was in one case 0·018in., and in another only 0·009in.; also that good or bad centring of punch and die had much to do with the maximum stress.

Besides the diagram, a full-page illustration of the punches is given.

† Inst. C.E.: Foreign Abstracts.

Trade Notes.

The directors of the Bristol Wagon and Carriage Works Company Limited announce a dividend of 5 per cent.

The works of Messrs. Alexander Shanks and Son, Dens Ironworks, Arbroath, are offered for sale by the trustee.

Messrs. Charles Cammell and Co., Sheffield, are putting down a Siemens plant at their Cyclops Steel and Ironworks.

Messrs. A. and J. Stewart and Clydesdale Limited, Glasgow, have secured a good order from the Admiralty for boiler tubes.

It is stated that the Consett Iron Company have secured the Admiralty order for about 7500 tons of plates for two new battleships.

The contract for a central station at Gotha, to the amount of £30,000, has been awarded to Messrs. Lahmeyer and Co., of Frankfort.

The New British Iron Company's Corngreaves Works will be offered for sale by auction at the Queen's Hotel, Birmingham, on July 13.

Mr. J. Thompson, Ellingshall Boiler Works, Bilston, has obtained an order for a boiler with Worthington pump for the Rye Town Council.

The Whessoe Foundry Company, Darlington, have obtained an order for a two-lift gasholder, 100ft. diameter, for the Mirfield Gas Company.

An order for several thousand tons of steel angles for the Manchester Ship Canal Company has been given to the Glengarnock Iron and Steel Company.

Mr. M. Pitts, Albion Ironworks, Stanningley, Leeds, has received an order for the steel girders, flooring, etc., for a new bridge over the river Witham, at Bardney.

Messrs. Crompton and Co. Limited, London, are to supply the engines, dynamos, accumulators, etc., for the electric-light plant for the Dewsbury Corporation.

The directors of Messrs. Head, Wrightson and Co., Teesdale Ironworks, South Stockton, recommend a dividend of 5 per cent. for the year ending April 30.

Messrs. Dunsmuir and Jackson, of Glasgow, have received an order for a set of triple-expansion engines for a steamer to be built by Messrs. A. Rodger and Co., of Port-Glasgow.

Messrs. Murdoch and Cameron, heating and ventilating engineers, Glasgow, have received an order for the heating and ventilating of the Brownlow Hill workhouses and asylum at Liverpool.

The report of the directors of the Neepsend Rolling Mills Company Limited states that the profit balance is very small, owing to the falling off in foreign trade. The repairs and renewal of plant, machinery, and buildings have been duly provided for out of the revenue.

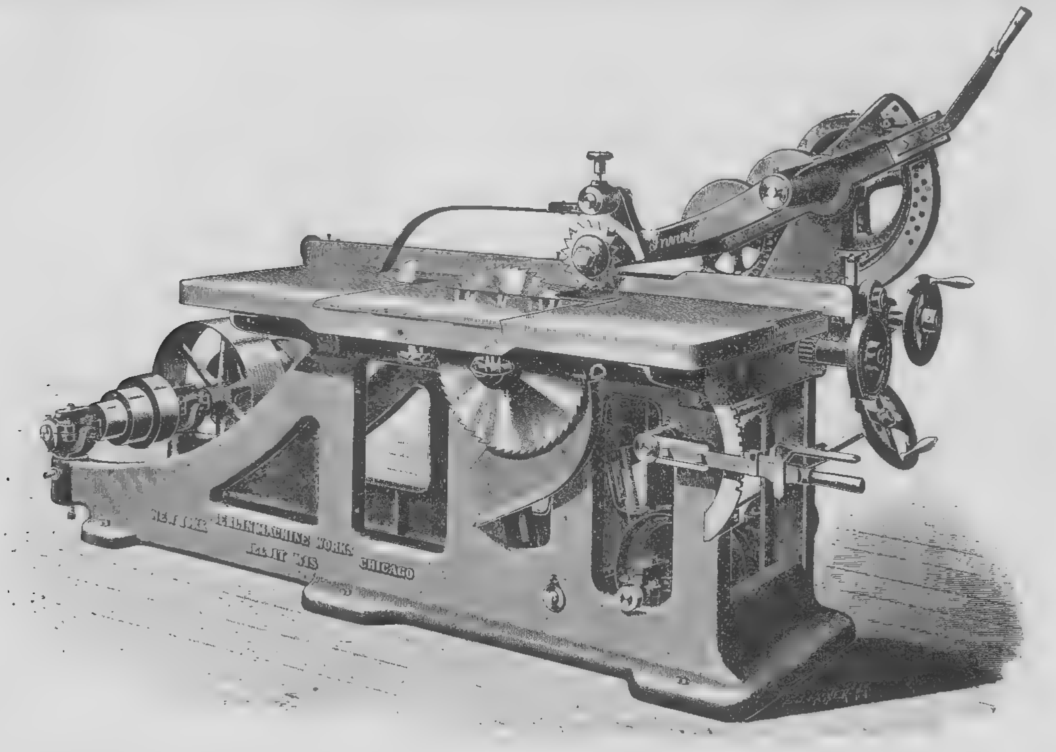
The directors of Messrs. John Brown and Co. Limited, Atlas Works, Sheffield, have decided to recommend the payment of a further dividend on the ordinary shares of the company of 12s. 6d. per share, making, with the interim dividend already paid, $7\frac{1}{2}$ per cent. for the year.

The annual report of the Ebbw Vale Steel, Iron, and Coal Company states that, considering the depression in trade, the results of the past year's working have been very satisfactory. After making provision for the depreciation of plant, etc., there is sufficient to pay a dividend of $2\frac{1}{2}$ per cent.; but the directors think that to pay any dividend would be unadvisable considering the present outlook and also the fact that the company is being re-established on a sound financial basis.

The Chicago Exhibition.—IV.

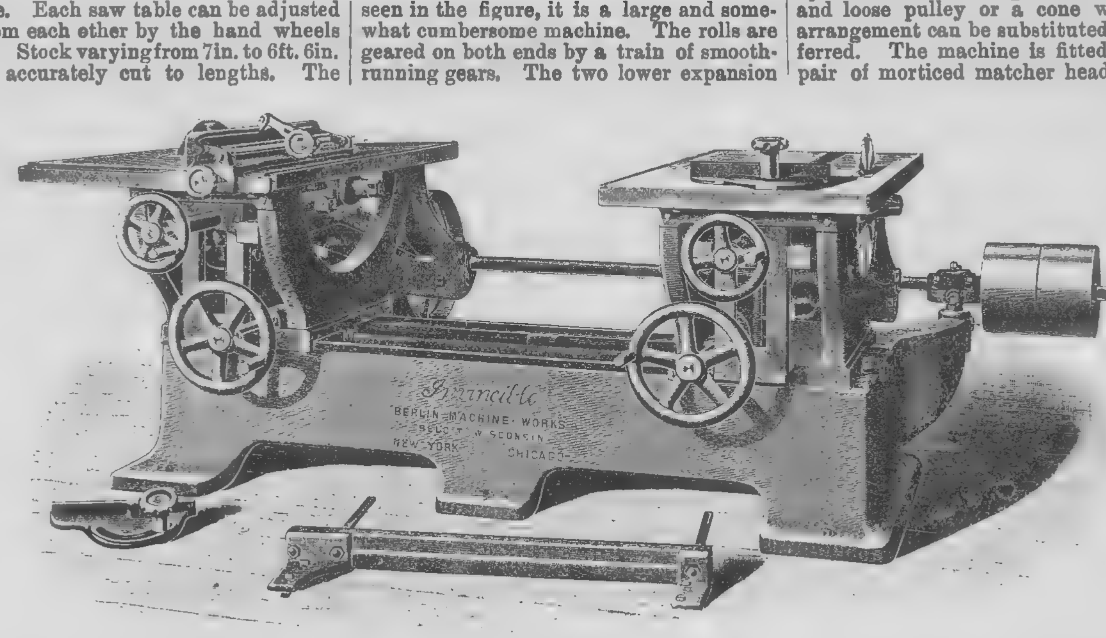
By Our Special Representative.

The "Invincible" self-feed saw (Fig. 10) is designed with special care to meet its requirements as regards heavy and constant work which a machine of this kind is often called upon to do. The frame is heavy and thoroughly braced. The table is stationary, and is bolted solid to the frame, which gives it great strength and rigidity. The feed mechanism is simple and positive, and is easily operated by a hand lever; it can be adjusted to feed any desired thickness of material. It is provided with a lateral adjustment, which keeps the feeding saw exactly in line with the cutting saw, and the material close up to the guide. It has three speeds of feed, operated by a belt tightener which is constantly under control of the operator. The feed of this machine can be governed from the saw arbour; this allows the feed to slow up if the saw is choked, and, of course, the feed stops when the saw is stopped. It is also designed to have the feed driven directly from the countershaft, which relieves the arbour of this aditional work. The saw can be raised or lowered by the hand wheel to suit the thickness of the material. The saw arbour is long enough to allow two saws to be operated at once if desired. It also has an outside bearing. The guide is geared at both ends, making it exactly parallel to the saw, and is operated by the hand wheel, which adjusts it to the desired width on the graduated scale. The throat piece is dovetailed into the table, and can be adjusted so as to allow groover heads or a wobble saw to be used. The largest size of saw worked in this machine is 18in. diameter. The total weight of the machine is 2800lb.



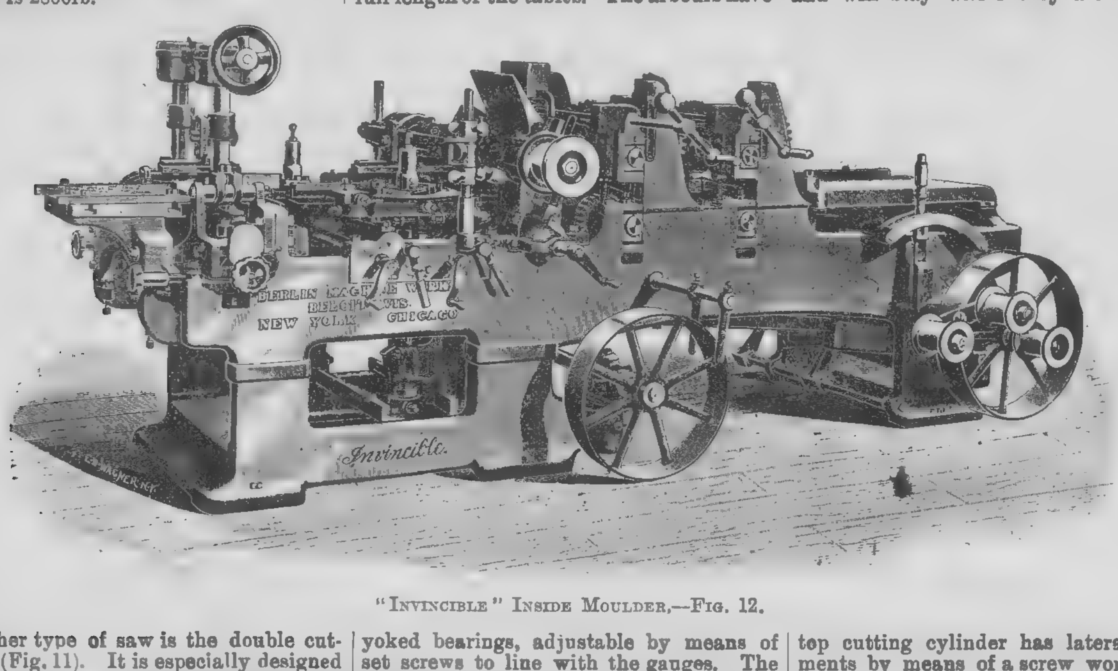
"Invincible" Self-feed Saw.—Fig. 10.

Another type of saw is the double cut-off saw (Fig. 11). It is especially designed for cutting to accurate lengths all kinds of material used in furniture and cabinet shops, etc. It is very heavy, strong, and substantial. The base is one casting cored out inside, and having on its top slideways for the separate saw tables and saws. Each of the saw tables is fitted with a saw arbour having vertical adjustment by means of small hand wheels in front of the machine. Each saw table can be adjusted to or from each other by the hand wheels in front. Stock varying from 7in. to 6ft. 6in. can be accurately cut to lengths. The left table is fitted with an improved splitting saw gauge, which will work to any angle. The side pieces for the gauges are of steel, and fit the grooves in the table very accurately, being also the full length of the tables. The arbours have yoked bearings, adjustable by means of set screws to line with the gauges. The countershaft hangers are attached to the base, and the driving pulleys for saw arbours are adjusted with the tables. The arbours have adjustable saw collars for a variation of $\frac{3}{8}$in. hole in the saw. The machine is designed to carry saws 16in. in diameter, and will cut stock to 5in. thick.



"Invincible" Double Cut-off Saw.—Fig. 11.

Passing to another machine, we have the "Invincible" inside moulder (Fig. 12). As seen in the figure, it is a large and somewhat cumbersome machine. The rolls are geared on both ends by a train of smooth-running gears. The two lower expansion gears are fast to the shaft, the latter running in bearings cast to the roller stands. The top expansion gears run idle on the top shaft. The top rollers are adjusted by a new arrangement of gears and screws, and will stay where they are set. The top cutting cylinder has lateral adjustments by means of a screw working into the frame. The stand is especially heavy, to absorb all vibration. The bearings are fitted on to the face of the stand by an arrangement of tongue and groove, and are scraped to get a perfectly true seat and to clamp on to the stand. The bearings for the top and bottom cutter heads are 2in. in diameter and 10in. long. The cutter heads, of course, are slotted on all four sides for extra large bolts. The chip breaker is sectional, and has adjustments to or from the cylinder. The under cylinder has vertical and lateral adjustments, independent of the tables, before or after the cut. The bearings are yoked together and firmly bolted to vertical flanges cast on the frame. The end table on the feeding-out end is pivoted to swing down, thus giving free access to the lower cutter head. This table has vertical and longitudinal adjustments for all kinds of deep or heavy cutting, and the pressure plate over the cylinder is so arranged as to be vertically over the cut. The sidehead mechanism is a most perfect arrangement. The bars on which the spindles slide are of peculiar shape, and cannot be worn out of true line. Each spindle has separate lateral adjustment, and is fitted with a patent eccentric clamping arrangement, which will clamp it in place firmly, taking up all back lash from looseness of screw threads, thereby ensuring perfectly smooth work in the cutter heads. Either one or both of the matcher spindles are made to angle. The left-hand matcher leg is fitted on top with an improved matcher plate, carrying an expansion weighted chip-breaker before the cut, and take-up guide arrangement after the cut, allowing a large swing for all kinds of moulding cutters; and they can be put close to the cut for fine flooring and ceiling. The top feed rollers are fitted with pull-out shafts for changing rollers, and fluted, smooth, sectional, spur, or any kind of feed rollers may be used as desired. The feed is stopped and started by means of a belt tightener, but a tight and loose pulley or a cone with clutch arrangement can be substituted when preferred. The machine is fitted with one pair of morticed matcher heads and one pair of four-sided slotted steel jointer heads, for moulding cutters and all necessary wrenches.



"Invincible" Inside Moulder.—Fig. 12.

(*To be continued.*)

The Manchester Association of Engineers.

The half-yearly meeting of the members of the above Association was held at the Grand Hotel, Manchester, on the 10th inst., Mr. Thomas Daniels, the president, in the chair. The proceedings were purely of a business character, and consisted mainly in the election of officers and new members. Messrs. E. R. Walker, of Messrs. Walker Bros., Wigan, and C. N. Pickworth, of The Mechanical World and "The Textile Manufacturer" (Messrs. Emmott and Co. Ltd.), Manchester, were elected honorary members, and Mr. H. Mainwaring, jun., of Charles-street, Manchester, an ordinary member. Messrs. H. Bates, C. Farmer, and J. Hartley were elected members of the committee of management, and Messrs. J. Simpson and R. Parry auditors for the ensuing six months. A resolution of condolence on the death of Mr. Richard Pearson, one of the members of the Association, was passed, and the meeting then closed.

The tallest tree on earth, so far as is known, is a gum tree (*Eucalyptus regnans*) in the Cape Otway Range, Australia. It is 415ft. high. Gum trees grow very rapidly; one in Florida shot up 40ft. in four years with a stem 1ft. in diameter, and another in Guatemala grew 120ft. in twelve years, with a stem 9ft. thick. This is at the rate of 10ft. a year, or nearly 1ft. per month.

The Cultivation of the Inventive Faculty.

IT will be recollected that in our issue for April 28 we invited solutions of a problem originally set by Mr. Leicester Allen in the "American Machinist." We reproduce below the conditions to be

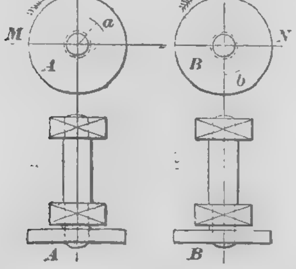


FIG. 1.

fulfilled, and the restrictions imposed, for convenience of reference:—

"In the figure two discs, A and B, are keyed to the ends of two parallel shafts fitted to turn in fixed bearings. A is

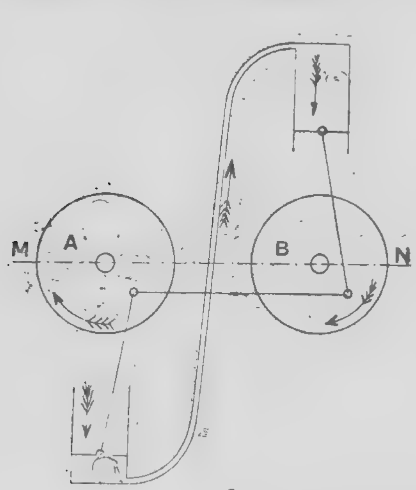


FIG. 2.

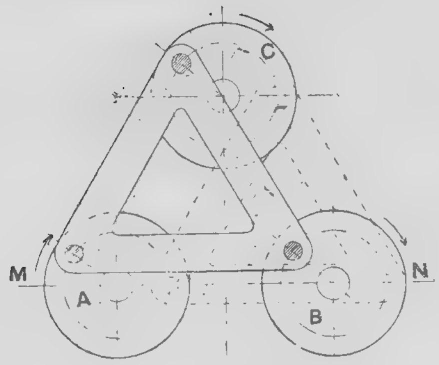


FIG. 3.

required to drive B by mechanism subject to the following restrictions:—

"1. If any point, as *a*, be taken in A, at a given distance from its axis of rotation, any point, as *b*, taken in B, at the same distance from its axis of rotation, must

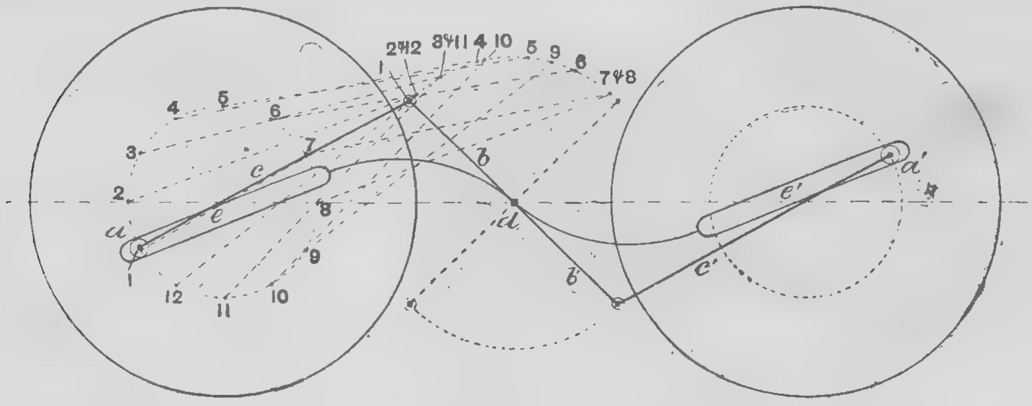


FIG. 4.

have, at any time, the same velocity of rotation that *a* has, or, as books on mechanics would put it, the velocity ratio of these points must be 1.

"2. This is now done in coupled driving wheels of locomotives by two cranks (or their equivalents) on each shaft, the cranks being set at an angle with each other—usually a right angle—and two coupling rods, but it must be understood *that such a device is rigidly excluded in the solution of this problem*.

"3. Belts of any kind, toothed gearing, friction wheels, or sprockets are excluded.

"4. The motion of the driven wheels must

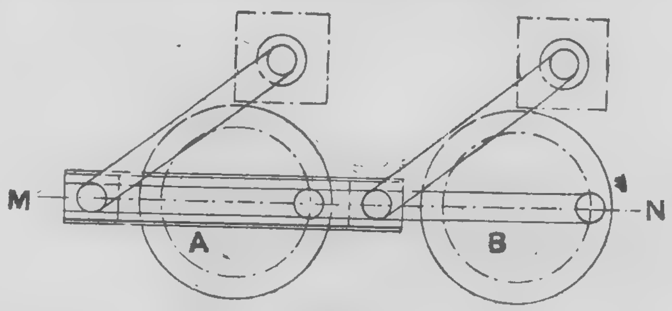


FIG. 5.

be continuous and in the same direction as that of the driver, so long as the driver continues to move in that direction. The direction of rotation is not required to be reversible, but if it can be made so it will be a desirable feature in such a movement.

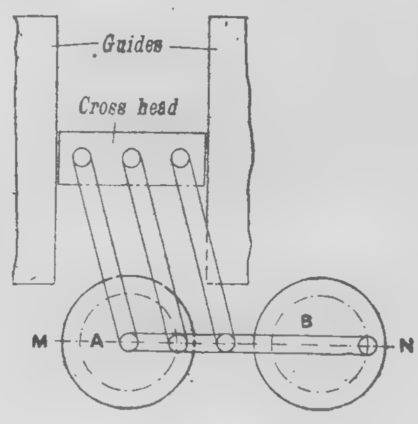


FIG. 6.

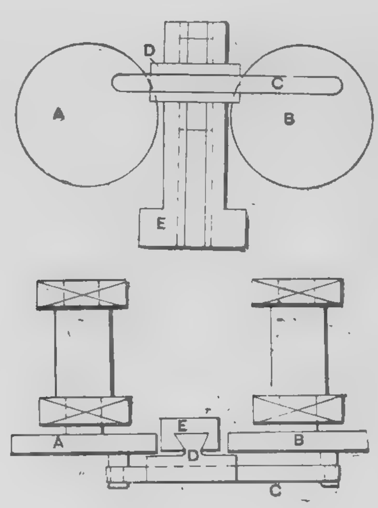


FIG. 7.

"5. There must be no dead point in the driven wheel; when the driver starts to rotate, the driven wheel must start also, no matter what position any point in it may occupy relative to the line of centres M N.

"6. The motion desired is extremely slow—one rotation of the driven wheel in 30 minutes,—and as the wheels are only 1in. in diameter, and the distance between their centres is 1½in., the mechanism may be extremely light. However, as there may be cases wherein a stronger movement of this kind might be desirable, I will add that the problem practically admits a solution for much larger wheels and higher velocities.

"The restriction that no toothed wheels, belting of any sort, or friction wheels are allowable, relates to *the immediate connection between the driving wheel A and the driven wheel B.* The driving wheel may itself be driven by any means desired.

"While solutions employing mechanism not carried by either the wheel A or B, or both of them, or by their shafts, will not be rejected if they do not overstep other restrictions, I will say that those solutions will be considered best that use only devices attached to and connecting the two wheels. The problem admits of a very neat solution in this way, and I hope this

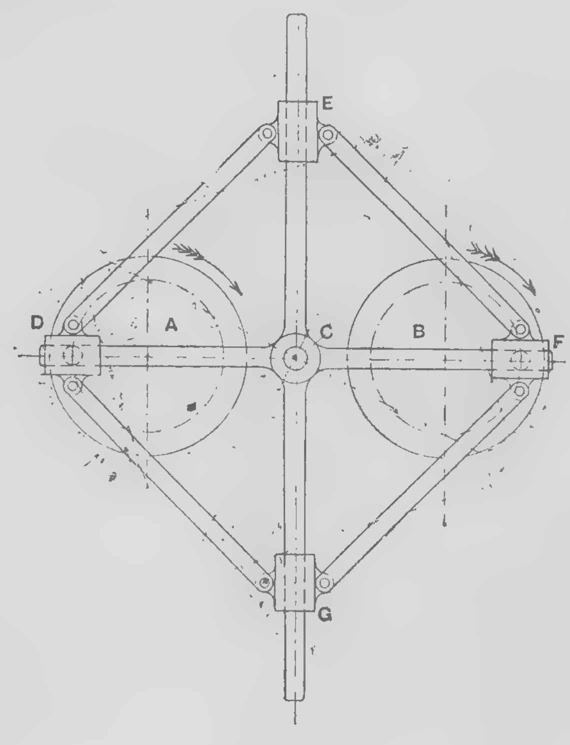


FIG. 9.

method will be perceived by many who will take the problem into consideration."

We may say that although the number of solutions submitted has not been large, yet several exhibit considerable ingenuity, as will be seen from the accompanying sketches and descriptions. We were somewhat disappointed to find so few attempt what may be called the "full solution of the problem," to accomplish which "only devices attached to and connecting the two wheels" could be employed. We received, in fact, only one solution of this class, and to this reference will be made later.

Several correspondents have not paid due regard to the conditions stipulated. For example, one solution offered entailed the use of two eccentrics on each shaft, fixed at right angles to each other and connected by two coupling rods. This combination is, of course, quite inadmissible, since it is only a disguised form of the method now used of coupling the wheels of locomotives, and such devices are by the conditions rigidly excluded. Other solutions sent in do not fulfil condition I.

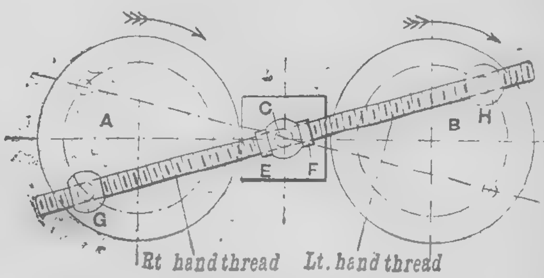


FIG. 8.

Thus, one gentleman suggests using a flexible shaft connected at one end to the front end of shaft B, and at the other to the rear of the shaft carrying A. It is obviously impossible in practice to ensure an exact velocity-ratio being maintained by such a combination, and this design must therefore be excluded. "Hydro" sends the device shown in Fig. 2, in which two crankpins in the discs are coupled together as shown, and also serve to drive two pistons in the small water cylinders indicated. Communication is established between the latter by means of the pipe shown, the idea being to avoid dead centres by the transmission of fluid pressure. Upon consideration, however, it will be seen that the arrangement as shown will fail to maintain the pressure, for the following reason:—When the crankpins fall in the line of centres M M, both pistons will have moved through more than the half stroke in consequence of the angular vibration of the connecting rods, so that there is a greater space between the pistons than when the cranks are vertical. This difficulty might be overcome by using a slotted crosshead in place of the ordinary connecting rod, but in any case the arrangement cannot be considered a mechanical one.

Messrs. T. Turley, C. H. Robinson, and

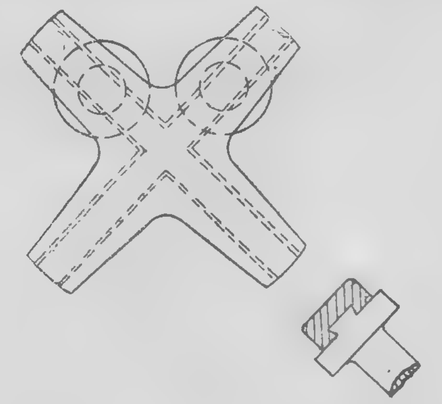


FIG. 10.

F. W. Thorley propose to use a triangular couplingrod (Fig. 3), the apex of the triangle being connected to the crank-pin of an idle disc C. It will be seen that no dead points are possible with this arrangement, for when, as shown in dotted lines, the cranks on A and B are in the line of centres, the crankpin of A exerts a pull on the pin of C, which produces a corresponding thrust on that of B and so carries it out of the line of centres. This arrangement is reversible, and offers one of the neatest and most practical solutions of the problem we have received.

Mr. Thos. Thirkell, of Middlesbrough, submits the very ingenious arrangement shown in Fig. 4, with regard to which he says:—"Either disc may be the driver, and the motion of the driven disc corresponds exactly with the driver; they will rotate in either direction and have no dead centre. The crankpins a a' are coupled to the rocking arms b b' by the links c c', b b' turning on the fixed centre d. The crankpins a a' are moved over the dead centres by the slotted arms e e' which move about the fixed centre d. Without the slotted arms the position of the discs as shown in the diagram would be exactly on the dead centres, which would also be the case if the crankpins were at the opposite end of the slot."

We are inclined to consider this solution among the most ingenious sent in. It is highly creditable to Mr. Thirkell, who, we may mention, has had no mechanical training whatever.

Figs. 5 and 6 show two arrangements by "B. T. J.," which fulfil the necessary conditions. In Fig. 5 the coupling rod is kept parallel to M N by being caused to slide to and fro in a frame carried by the two links shown. In Fig. 6 the same end is accomplished by linking the rod to a sliding crosshead, working between vertical guides as shown. These arrangements are not by any means the best from a practical point of view, but they nevertheless afford interesting solutions of the problem.

Mr. F. Voile submits a somewhat similar device, which is shown in Fig. 7. Here, as will be seen, the coupling rod reciprocates in a long guide block, which in turn is arranged to slide vertically in the fixed upright standard E.

Two ingenious but somewhat complicated solutions, offered by "T. J. H.," are shown in Figs. 8 and 9. In the first case C is an eye which carries a rod screwed right and left-handed. G and H are nuts threaded on the two screwed portions of the rod, and being carried by the discs A and B. E and F are collars to keep the screw in position, and both G and H, as well as C, are capable of oscillating about their centres as required. It will be evident that the pitch of the screws must of necessity be very coarse, and that there will be considerable friction and wear with this device.

A better solution is shown in Fig. 9, where the oscillating lever takes the form of a cross turning about a fulcrum, as shown. The four arms carry sliding pieces D, E, F, G, these being joined together by the four coupling links. The illustration will enable the motion to be understood without further description. We are inclined to regard this arrangement as being in every way preferable to that shown in Fig. 8.

Mr. H. M. Stuart, Glasgow, has submitted the only solution which does not require independent support. This, as will be seen from Fig. 10, takes the form of a coupling having two grooved recesses at right angles to each other, into which engage projecting ridges on the faces of the discs, as indicated. We believe this solution best fulfils the conditions imposed, as it is very simple in construction, and is carried wholly by the two discs.

In conclusion, we may add that it is possible Mr. Leicester Allen may comment upon the solutions we have published. We shall probably submit other problems of a similar character at some future date, as we find that considerable interest has been taken in the one we have given.

State of the Skilled Labour Market.

THE following memorandum has been communicated to the "Board of Trade Journal" by the Labour Department of the Board of Trade:—

On the whole the state of employment has improved during the past month. This is the more noticeable as occurring along with the Australian banking failures. The collapse of credit in Australia is one of those events which, according to past experience, are likely to react unfavourably on the foreign trade of the United Kingdom, and possibly to postpone for a time the revival of trade, of which certain symptoms appear in some of the local reports published in the "Labour Gazette."

Twenty-six societies make returns for the month, including 307,959 members, of whom 19,391, or 6·2 per cent., were unemployed at the end of May, compared with 20,478, or 6·9 per cent., of unemployed shown by the 23 societies which made returns for April.

The percentage of unemployed is still slightly higher than for the corresponding month of 1892. The percentage of unemployed in the engineering and shipbuilding trades has only slightly fallen (viz., from 8 to 7·8), but the improvement would probably have been more noticeable but for the effect of the Whitsuntide holidays, which more or less affected employment in many industries. The most marked improvement is in the Oldham cotton-spinning trade, which has now assumed its normal condition. Last month the Oldham district, which had not yet settled down completely after the great dispute, showed no less than 1804, or 28 per cent., of members of the Cotton Spinners' Union out of employment. The present return shows only 145, or 2·2 per cent., unemployed. Little change is reported in the woollen trade. Of the 26 unions making full returns, 11 describe trade as "good," seven as "moderate," and eight as "bad." The building and furnishing trades continue to find full employment for their members, the percentage of unemployed returned by the building trades remaining stationary (2·3), while that returned by the furniture trades has slightly risen (from 2·5 to 2·9). The printing and kindred trades are only moderately employed, regard being had to the season of the year. The bespoke branches of the clothing trades as returned are exceptionally busy, very little want of employment being felt; but the wholesale clothing and boot and shoe trades are somewhat depressed, the export branches being probably affected by the financial disasters in Australia. Mining is depressed in Scotland, the North of England, and Yorkshire, a large number of mines being quite idle and many collieries working short time. In South Wales the mining industry appears to be more active.

Though no fresh dispute of a very extended character has arisen during the month, the number of new disputes reported has reached 87, an increase of 14 when compared with last month, but a decrease of six when compared with the corresponding period of 1892. The principal industries affected have been the various branches of the building trades which account for no fewer than 39 out of the 87 disputes.

Though strikes in the building trade are not uncommon at this season of the year, this number is considerably above the average, owing, no doubt, to the good state of trade, which, in turn, is probably due in part to the long spell of fine weather; 13 arose in connection with mining, seven in the clothing, and seven in the textile trades, six were connected with seafaring and dock labour, five with the shipbuilding, and four with the metal trades, the remainder being accounted for by various miscellaneous industries. In the 63 strikes for which full particulars have been obtained, 34,950 persons were engaged. The dispute in the shipping trade at Hull came to an end during the month, but there is still some friction at the port.

Hydraulic Lifts.

(*Continued from page* 237.)

SUSPENDED LIFTS, on account of their greater cheapness, and their not requiring a well and cylinder sunk in the earth, are becoming more common than they were a few years ago. They have also been greatly improved in detail and construction. Chains have given place to wire ropes; the multiplying sheaves have been greatly increased in diameter with beneficial results, friction being reduced and the life of the wire ropes increased. For passenger use it is almost the universal practice now to suspend the cage by four wire ropes; for warehouse and goods lifts sometimes purchasers are content with two, but very rarely one, except for very light loads When there are four ropes, each one is of ample strength to do the work alone; and they are carefully examined at frequent intervals, say once every month, to see if there are any signs of wear, and directly such are detected the rope is removed and a new one put in its place. It is very difficult to imagine that there is much danger from the failure of the ropes, especially if there is a good safety-apparatus. It has been suggested that where there is more than one rope to carry the cage, all the weight should be carried by one, and the other, or others, should simply run idle, merely being kept taut by springs, so that no stress or shock can be communicated to them. By this arrangement it is claimed that the working rope alone will be liable to break; the others having to bear no strain will last much longer and be in a perfectly good condition long after the working rope is worn out. Should the working rope break, the other ropes being comparatively unworn will not be likely to break when the full weight of the cage is suddenly thrown on them. The author has had no experience, and does not know whether the ropes passing over the sheaves without being loaded would last much longer than the rope which had all the weight of the cage suspended thereon, but he thinks the probability is that they would. If so, perhaps this alone would be the most effectual safety arrangement that could be applied, as it could not fail to act when the critical moment arrived. Another suggestion is that, in the event of the working rope breaking, the other rope or ropes may be made to exert all their strength to apply the safety cams. It would thus be almost impossible for the cage to drop, or, in fact, descend at all until the ropes were again made right, for assuming the ropes were so much worn that they were unable to withstand the shock of the weight of the cage being thrown on them, they would still be amply strong enough to pull the cams into action. This they must do before they take any strain at all worth mentioning, and therefore before any shock could affect them; they would only have to compress the springs that in the ordinary course of working kept them just taut, slightly more than before the working rope broke. That would be all the extra work required of them, for when once the cams were in contact with the wooden slides or runners they would grip and hold fast, should the cage be descending; but if ascending they would only drag on the runners, but not bite. In the foregoing suggestions the principle is adopted that it is better to wear out one rope first, the others being kept in reserve to meet the contingency of the first rope breaking; if only one out of two or more breaks no great harm is done.

There are many kinds of safety appliances in use for preventing the descent of the cage should the suspending ropes break, and it appears to be the fashion, so to speak, to have for passenger lifts four steel-wire ropes all doing equal duty, the safety apparatus being so constructed that should any one of the four ropes break the others pull into action the safety cams or grips. In most of these arrangements, however, there is the fault that if all four ropes were to break simultaneously the safety gear would not come into action at all; and in some, if two ropes were to break at the same instant, the other two would not apply the safety cams at all. To meet this contingency, a fifth rope of less strength than the other four is provided, with the sole object of forcing the cams or grippers into action should all the other ropes break. The multiplication of ropes, and the excellent safety appliances now in use, leave little to be desired in preventing accidents by the failure of ropes; but there is another inherent source of danger connected with suspended lifts, although happily a remote one—that is, the failure of the overhead sheaves or spindles. Beyond making these of extra strength it is not usual to take any special precaution; the only protection that could be suggested would be a strong floor or grid under the top sheaves, but this would be inadmissible in most cases on account of its unsightliness and the obstruction of light. If, however, proper care is exercised in designing these parts and in testing them before they are erected, very little danger need be anticipated from this quarter.

(*To be continued.*)

Metal Trade Memoranda.

It is stated that another syndicate for the manipulation of copper is being formed.

The arrivals of lead this year are 74,535 tons, being 2000 tons less than in 1892, but the loss in value is £149,000.

The copper statistics issued by Messrs. H. R. Merton and Co. show that the total stocks on the 15th inst. were 49,012 tons, as compared with 49,951 tons on 31st May.

The imports of iron ore into the Clyde from Spain in May amounted to 22,300 tons, compared with 47,020 in May, 1892, and the arrivals of this ore for the last five months are 185,578 tons, against 264,453 in the first five months of 1892.

The imports of copper ore into the Clyde during the month of May were 4762 tons, against 3293 tons in May, 1892, and the arrivals for the first five months are 27,384, as compared with 22,634 in the corresponding period last year.

Messrs. D. Colville and Son, Dalziel Iron and Steel Works, Motherwell, are erecting a sheet mill at their works.

The Wohlfahrt Lead Mines Limited have declared out of the profits a dividend of 3 per cent. in respect of the year ended December 31, 1892, making, with the interim dividend, a total division of 8 per cent. for the year.

Several tons of iron ore were recently sent from the district of Newcastle, in Natal, to England to be tested and manufactured into articles for which it was thought suitable, The ore has been found to be well adapted for the production of steel, and a quantity of cutlery has been made from it.

New Companies.

JOHN SADLER LIMITED.—This company was registered on the 10th inst., with a capital of £10,000, in £10 shares (of which 850 are ordinary and 150 5 per cent. preference), to acquire the business of wrought-iron hinge, wire, nail, and rivet makers, heretofore carried on as John Sadler, at Spring Hall, Birmingham, and to continue this business for profit. Table A generally applies. Registered by Bolton and Co., 3, Temple Gardens, E.C.

DIRECT-AUTOMATIC STOKER SYNDICATE LIMITED.—This company was registered on the 9th inst., with a capital of £20,000, in £1 shares, to adopt an agreement made between the vendor, C. H. Redfern, and F. Harrison, and to carry on the business of ironfounders and all similar trades. The number of directors is not to be less than 3, nor more than 7; qualification, £250; remuneration, £100 per annum each. Registered by Pritchard, Englefield and Co., Painters' Hall, E.C.

MERIONETHSHIRE ELECTRIC LIGHTING AND POWER APPLIANCE COMPANY LIMITED.—This company was registered on the 9th inst., with a capital of £3000, in £1 shares, to establish and carry on at Dolgelly and elsewhere in Merionethshire, the business of an electric lighting and electric power supply company, together with the trade of electricians and mechanical engineers. Six of the signatories are to be the first directors of the company; qualification, 10 shares. The regulations of Table A apply in most cases. Registered by Jordan and Sons, 120, Chancery-lane, W.C.

PIONEER ELECTRIC CARRIAGE COMPANY LIMITED.—This company was registered on the 8th inst., with a capital of £20,000, in £50 shares, to develop traction and propulsion of vehicles or carriages on tramways, highways, and roads by means of electricity; to construct electrically-propelled or other vehicles; and to enter into an agreement with the Electrical Power Storage Company. The number of directors is not to be less than 2, nor more than 7; qualification, £100; remuneration to be fixed in general meeting. Registered by Renshaw, Kekewich and Co., 2, Suffolk-lane, E.C.

RICHARD POORE AND CO. LIMITED.—This company was registered on the 10th inst., with a capital of £6000, in £1 shares, to adopt an agreement made between Richard Poore and Walter Wheeler, to acquire the patent referred to in this agreement, and to obtain any inventions capable of being used to advantage; to construct any buildings or works necessary or convenient for the object of the company, and to carry on the business of electricians, suppliers of electricity for the purpose of light, heat, or motive power, and general engineers. Messrs. A. Blythe and G. V. Currie are the first directors of the company; qualification, 100 shares. Registered by T. D. Pettiver, 21, College Hill, E.C.

THOMAS A. ASHTON LIMITED.—This company was registered on the 7th inst., with a capital of £30,000, in £10 shares, to enter into an agreement made on February 22 last between T. A. Ashton, the vendor, and J. Worthy, both of Sheffield, Yorkshire, for the purchase of all money and securities for money, book and other debts and credits belonging to the vendor in connection with his business of engineer, engineers' factor, and general machinery merchant, and the goodwill, plant, etc., of this concern; also to carry on the business of engineers and other auxiliary trades. The rules of Table A mostly apply. Registered by C. Doubble, 17, Serjeant's Inn, E.C.

CLARKE, CHAPMAN AND CO. LIMITED.—This company was registered on the 14th inst., with a capital of £150,000, in £5000 6 per cent. preference and 10,000 ordinary shares of £10 each, to purchase the lands, offices, patent rights, books, and other debts, and all effects of or belonging to or used in or about the trade or business of engineers, founders, smiths, and machinists, now carried on by Clarke, Chapman and Co., at Victoria Works, in Gateshead, to enter into an agreement for the purpose, and to carry on the business of engineers, etc. Messrs. H. H. Chapman, J. B. Furneaux, and H. R. Chapman are to be the first directors; qualification, £2000, or upwards. Registered by Pattison, Wigg and Co., 11, Queen Victoria-street, E.C.

WILLIAM PARNALL AND CO. LIMITED.—This company was registered on the 14th inst., with a capital of £30,000, in £10 shares, to acquire the business of a grocer's outfitter now carried on by Wm. Parnall, at Victoria-street, Temple-street, Bristol, at 15, Seething-lane, E.C., and 16, Hanging Ditch, Manchester, under the style of Wm. Parnall and Co., and to carry on in their respective branches trades of scale makers, smiths, brass founders, weighing-machine manufacturers, engineers, electricians, and suppliers of electricity. The first directors are: Wm. Parnall, G. B. May, and F. Johns; qualification, £100; remuneration to be paid out of the funds of the company. Registered by Salisbury and Griffiths, solicitors.

FORD-LLOYD MANUFACTURING COMPANY LIMITED.—This company was registered on the 7th inst., with a capital of £10,000, in £1 shares, to purchase the business of electrical engineers and manufacturers of electrical appliances heretofore carried on by the Ford-Lloyd Manufacturing Co., at 8, Mount Pleasant, Clerkenwell, E.C., and the sole right to sell and dispose of the invention known as the "E. S. dry battery," and the assets and liabilities of that firm in connection with the above-mentioned business, and also the premises known as the Penarth Works, Bermondsey, S.E.; to enter

into an agreement for that purpose, and to carry on the business of electrical engineers and analogous trades. Many of the rules of Table A apply. The first directors are: E. J. Tumber, A. Ford-Lloyd, and C. H. Elliot; qualification, £500. Registered office, 2 and 4, Phœnix place, Mount Pleasant, W.C.

CUNNAH-WRIGHT PATENT CONSTRUCTION COMPANY LIMITED.—This company was registered on the 14th inst., with a capital of £25,000, in 4800 ordinary "A" shares of £5 each, and 1000 deferred "B" shares of £1 each, to carry into effect an agreement made between H. L. Cunnah and A. O. Wright, to acquire and carry on the business of Messrs. Cunnah-Wright and Co., in so far as it relates to the manufacture of patent corrugated iron laths and sheets for use in the formation of ceilings, roofs, partitions, and other purposes; to purchase patents, etc., and to carry on the business of ironfounders and other cognate trades. The number of directors is not to be less than 3, nor more than 7, the first being H. L. Cunnah, A. O. Wright, Gen. G. D. Pritchard, F. W. Allinson, and F. H. Macey; qualification, 100 ordinary shares; remuneration, £100 per annum, with £25 a year extra for the chairman. The board is also to receive percentage on the profits. Registered office, 28, Gracechurch-street, E.C.

The Metal Market.

PRICES CURRENT.

LONDON, June 19.

COPPER opened firm and active, with cash 6s. 3d. better at £44 17s. 6d., and advanced to £45 2s. 6d. one month, and £45 cash, after which the market became quieter, and cash was done at £44 17s. 6d. On a renewal of good buying, however, £44 18s. 9d. and £45 were paid for cash, while three months, after beginning at £45 5s., went to £45 6s. 3d., and in the afternoon to £44 8s 9d. After the official close, £45 1s. 3d. was paid for cash on covering purchases, and the close was firm at 10s. advance. Purchasers by the syndicate and on Paris account are reported as the cause of the improved movement. Sales, 1900 to 2000 tons. Settlement price, £45. English tough, £47 10s.; best selected, £49; strong sheets, £55 to £55 10s.

TIN, owing to the scarcity of spot offerings, gained 10s. during early trading, a small quantity realising £89, but the market was inactive, the close being steady at the opening advance. Settlement price, £89. English ingots, £92. Amsterdam market very firm. Billiton, $53\frac{1}{2}$; Banca, $54\frac{1}{2}$.

PIG IRON has been inactive, but prices for Scotch have ruled firm, bids of 41s. $9\frac{1}{2}$d for cash being refused, and final rates are $\frac{1}{2}$d. better. Middlesbrough, however, is $\frac{1}{2}$d., and hematite 2d. to 3d. worse. Settlement prices:—Scotch, 41s. $10\frac{1}{2}$d.; Middlesbrough, 34s. 10d.; hematite, 45s.

TINPLATES are dull but steady. I. C. cokes, f.o.b. Swansea, 11s. 6d. to 11s. $7\frac{1}{2}$d. per box.

LEAD has been lightly offered and closes at £9 10s. sellers, showing a rise of 2s. 6d. English, £9 10s. to £9 12s. 6d.

SPELTER steady at £17 12s. 6d. buyers, prompt shipment, with sellers at £17 15s.

ZINC SHEETS.—Silesian quiet, but steady at £20 10s. ex ship, while the V.M. brand is offering at £21 5s. ex ship, and £21 2s. 6d. f.o.b. Antwerp.

OFFICIAL CLOSING QUOTATIONS.

	To-day. £ s. d.	£ s. d.
COPPER—		
G. M. B.—Cash	45 0 0	—45 7 6
" Three months	45 8 9	—45 16 3
TIN—		
Fine foreign—Cash	89 0 0	—89 10 0
" " Three months	86 0 0	—86 10 0
Australian—Cash	89 12 6	—90 2 6

PIG IRON—

	Scotch. Cash. s. d.	Scotch. 1 m'th. s. d.	Middlesbrough. Cash. s. d.	Middlesbrough. 1 m'th. s. d.	Hematite. Cash. s. d.	Hematite. 1 m'th. s. d.
Close	41 $10\frac{1}{2}$	42 $0\frac{1}{2}$	34 10	35 0	45 0	45 3
Prev. close	41 10	42 0	34 $9\frac{1}{2}$	34 $11\frac{1}{2}$	45 3	45 5

GLASGOW, June 19.—The pig-iron market is more active, 10,000 to 12,000 tons of Scotch changing hands at the forenoon session, and 3000 to 4000 in the afternoon. Prices were again very firm, moving between 41s. $8\frac{1}{2}$d. and 41s. $11\frac{1}{2}$d. cash, the finish being at the highest. The demand is said to be partly on foreign order. During the afternoon Gartsherrie and Eglinton brands were advanced 6d. a ton. There was nothing doing in Cleveland or hematite, but prices were stiffer.

QUOTATIONS:—

	Scotch. Cash. s. d.	Scotch. 1 m'th. s. d.	Middlesbrough. Cash. s. d.	Middlesbrough. 1 m'th. s. d.	Hematite. Cash. s. d.	Hematite. 1 m'th. s. d.
Highest	41 $11\frac{1}{2}$	42 1	34 10	35 0	45 0	45 3
Lowest	41 $8\frac{1}{2}$	41 $10\frac{1}{2}$	34 9	34 11	45 0	45 3
Close	41 11	42 $0\frac{1}{2}$	34 10	35 0	45 0	45 3
Prev. close	41 10	42 0	34 $9\frac{1}{2}$	34 $11\frac{1}{2}$	45 3	45 5

Official Gazette.

Partnerships Dissolved.

A. C. ARGLES, Queen Victoria-street, E.C., and W. WARD, the younger, Birmingham, arms and ammunition manufacturers, under the style of the Arms and Ammunition Manufacturing Company.

D. T. DOCKER and C. Y. R. BEDFORD, metal merchants, Birmingham, under the style of Docker and Bedford.

THE BANKRUPTCY ACTS, 1883 AND 1890.

Receiving Order.

SAMUEL WILLIAM WORSSAM, Idol-lane, E.C., civil engineer.

Adjudications.

ALFRED ERNEST ROGERS, Darlington, wire worker.

JAMES THOMPSON, trading as J. Thompson and Son, Wigan, hot-water engineer.

GEORGE TINN, Bristol and Clifton, trading with Joseph Tinn, at Deep Fields, near Wolverhampton, as George Tinn and Co., as sheet-iron manufacturers, sheet-iron manufacturer.

Order Made on Application for Discharge.

JOHN HENRY WILSON, trading as George Wilson and Sons, Leeds, bolt and screw maker—discharge suspended for three years, ending May 18, 1896.

Letters to the Editor.

*** *We do not hold ourselves responsible for opinions expressed by correspondents.*

*** *The name and address of the writer (not necessarily for publication) must in all cases accompany letters intended for insertion, or containing queries.*

*** *Letters intended for publication in the current week's issue must reach our Manchester Office not later than by the first post on the Tuesday preceding the date of publication.*

DO WATER WHEELS RUN FASTER AT NIGHT THAN IN THE DAY?

To the Editor of THE MECHANICAL WORLD.

SIR,—The following extract, taken from the "Miller," may, I think, be of interest to some of your readers:—

"A German contemporary has opened its columns to this curious question, which is answered in the affirmative by the majority of its correspondents. The reason for this alleged phenomenon is the greater density of water after the sun has set. With an increasing temperature there is an expansion of the particles of which the water consists; and this, while diminishing their density, lessens the weight and driving force of the stream. So at least the writer argues; and he alleges, in support of his theory, the fact that at noon on a sunny day or during the course of a warm afternoon, weirs will require more often opening than in the morning or after nightfall, although the amount of work may be identical. In winter, too, he holds, the weirs will claim less attention than in summer."

J. MORGAN.

Retford, June 15.

TELEPHONY *v.* ELECTRIC TRACTION.

To the Editor of THE MECHANICAL WORLD.

SIR,—My attention has been called to an article in your paper headed "Telephony *v.* Traction," in which it is stated as "significant" that not only were the proceedings of recent meetings of the Municipal Corporations' Association kept secret, but also that I, the President of the Association, who occupied the chair, had recently become a director of the Telephone Company.

Permit me to inform you that both these allegations are without foundation. The Press does not attend our meetings, and nothing was "kept secret," and when the last of them was held I had not only not joined the Telephone Board, but have not yet done so, though I am considering an invitation from the Board to that effect, which has only just reached me.

ALBERT K. ROLLIT.

London, June 10.

Miscellaneous Items.

A report from Ashford, Kent, states that a coal seam has been discovered there about 24ft. below the surface.

An electric instrument for recording the speed of rotation of ships' shafts has been brought out by Messrs. Siemens and Halske.

A new iron observation tower is to be built at the Niagara Falls. It will be 290ft. high. The old tower has been removed, because its foundation was considered unsafe on account of an encroachment of the Falls.

Some interesting and successful experiments have just been made at Marseilles in stoking tugs with briquettes of solidified petroleum. It is stated that these briquettes generated heat three times more intense than ordinary coal, weight for weight.

We have received the first number of a monthly journal bearing the title of the "Canadian Engineer." It is intended to deal with the mechanical, mining and the various branches of the engineering trades, and may be obtained from the "Canadian Engineer" Company, Fraser Building, Montreal.

The members of the Manchester Association of Engineering Students paid a visit on the 15th inst. to the head fire station at Jackson's-row. Mr. Savage, the superintendent, explained the uses of the different apparatus, the visit being concluded by an exhibition by the firemen.

The laying of a duplicate cable of the Central and South American Telegraph Company has been completed. The new cable is 2524 miles in length, and extends from Salina Cruz, in Mexico, to Chorillos, a port near Lima. It was manufactured in London and has been laid within ten months, an accomplishment which is said to eclipse all previous operations in the laying of submarine cables.

It is stated that the Compagnie des Mines de Noeux, in the Pas-de-Calais, is having laid down an extensive electric mining plant for various purposes. The generating plant comprises two dynamos, and current will be transmitted a distance of $2\frac{3}{4}$ miles for the operation of five lifts, ranging in power from 6H.P. to 15H.P. Five pumps will be driven by electric motors, and a tramway 1·24 mile long will be worked electrically, each train consisting of twenty-five wagons. In addition to these applications, the illumination will be effected by arc and incandescent lamps.

It is stated that a proposal has been made to the Department of Public Works to construct a tunnel under the bed of the river Neva at St. Petersburg. It will be circular in section, 43ft. in diameter, and 410ft. long, and will be divided lengthwise into four storeys. In the first the telegraphic and telephonic cables will be laid. The second will be for the use of foot passengers. The third will be used by carriages and other vehicles, whilst in the fourth will run the tramcars. The construction of the tunnel is estimated to cost about £400,000.

At a recent meeting of the members of the Manchester Geological Society, held at the Mining School, Wigan, the proceedings were devoted to questions connected with mining. Mr. Thomas Grundy read a paper on "The Sinking of a Shaft under the Cages at the Wigan Junction Colliery," in which he described the methods adopted for removing the débris from the sinking without stopping the pit. A discussion followed on the substitution of iron and steel for timber in mines, during which the opinion was generally expressed that, although iron and steel props and girders might be used with advantage under a permanent weight, where there was a moving roof timber props were much to be preferred.

Queries.

☞ **Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.**

☞ **Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.**

TURNING CHILLED ROLLS.—Can any reader oblige me with any information on this subject?—T. A.

WOOD'S AUTOMATIC PRESSURE RELIEF VALVE.—Required the address of the makers of this valve.—BELL AND CO.

OIL MERCHANTS.—Will any reader give me the London address of the Cleveland Lubricating Oil Company, U.S.A.?—A. H.

WALTON WHEEL SCALE.—Required, information regarding the Walton Wheel Scale, or where it can be obtained.—A. L. J.

RAILWAY CROSSINGS.—Given the ratio of angle of intersection, say 1 in 8, what is the simplest method to convert into degrees of the quadrant?—L. V.

WIRE GAUZE.—Can any reader give a rule for the reduction of the effective area of a pipe by the interposition of a layer of wire gauze?—GAUZE.

CHURCHILL SLIDE VALVE.—Can any correspondent inform me who are the makers of the "Churchill Patent Slide Vale"? Any information would be thankfully received.—J. M.

GUTTA-PERCHA.—Can anyone tell me of a process for melting either raw or manufactured gutta-percha, and how, after moulding, to cause the gutta to set firm and solid?—J. C. W.

RETEMPERING EDGE TOOLS.—Will any reader inform me if there is any method of tempering pattern makers' chisels and gouges that have been burnt in a pattern-shop?—CYMRO.

CLEANING BOILER TUBES.—Will some reader describe a useful tool to remove hard thick scale from cross tubes in a vertical boiler? Tubes 9in. diameter and 4ft. 6in. long.—NOVICE.

WARSOP AERO STEAM ENGINE.—Any information about the working of the above engine, tried about 1870, such as the effect on the boiler, cylinder, piston rod, etc., will oblige—M. R.

GALVANISING.—Can any reader inform me whether it is possible to do galvanising on a small scale, say 3 or 4cwt. spelter bath; also the process of preparing cast-iron work for the bath?—T. J.

EMERY TAPE MACHINES.—I have an emery tape machine that I have a lot of trouble with through the tapes breaking continually. Can any reader who has a similar machine recommend a good tape?—CHEVIOT.

GAS ENGINE.—I have a gas engine with a separate compression cylinder by Storrie and Co., Glasgow. Can any reader inform me what the compression ought to be per square inch to obtain the best results?—J. PEARSON.

CASE-HARDENING FURNACE.—Will any practical reader give a sketch of a good furnace for case-hardening purposes, cutter-heating, etc., gas, liquid fuel, or coke, or the name of any maker of such?—LISTER AND CO., Keighley.

STEAM REVERSING GEAR.—I should be much obliged if any reader will explain the working of a steam reversing gear for locomotives, which I have seen on the following railway companies' engines:—Glasgow and South-Western, Mersey Tunnel, and South-Eastern. A sketch would assist me.—F. TURTON.

FLOWING WATER.—A river flows at the rate of, say, 20 miles an hour. If a tube perfectly smooth inside, of 2ft. diameter, were placed in the stream parallel to its surface, at what velocity would the water pass through the tube? Is there any rule for calculating this, and, if so, where can I find it?—SIGMA.

THEORETICAL DIAGRAMS.—Will any reader sketch and describe the theoretical indicator diagrams which would be obtained from a set of triple-expansion engines, having given—Load on safety valves, 150lb.; height of barometer, 30in.; ratio of cylinder volumes, 1, $2\frac{1}{4}$, 5; total ratio of expansion, 8?—HYPER.

STAKING ON WHEELS, ETC.—Will any reader inform me of the best method of staking wheels or pulleys on shafts, say, with four or six keys? Should they be set true opposite the staking wedge, or opposite the permanent keys? Some information on this subject, or a sketch of same, would greatly oblige—STAKING WEDGE.

KEYS, COTTERS, ETC.—Can anyone inform me what kind of steel is used for making keys and cotter pins as used on most engines? The keys that are bought seem to be of better quality than the so-called mild steel as sold at very little more than the price of fair merchant iron.—STEEL.

CONDENSING COIL.—In constructing a condensing worm and tank, what amount of coils are necessary, so that the distilled water may be quite cold, and what would be the quantity of water in tank to obtain the result? How can I arrive at the final temperature of water originally cold which has passed through 500ft. run of $1\frac{1}{4}$in. pipe, the pipes being immersed in a tank containing water at a temperature of 200° F.?—CALOR.

FEED PUMPS.—In working out feed pumps for common high-pressure engines, Molesworth says, p. 493—"Take cubic contents of cylinder and one steam passage and multiply by 4, and divide by proper specific volume for given pressure." Why multiply by 4? There are only two cylindersful of steam discharged to one revolution or one stroke of the pump. Then, again, should not the cubic contents of cylinder be taken to cut off only? For instance, if steam is cut off, say, at half-stroke, and initial pressure be 100lb., the specific volume for which is 270, we find a great difference from the plan of taking the full cylinder at the average pressure, which at 100lb. initial pressure will be 75 average, the specific volume for 75 being 353, not to mention the difference in the two cubic capacities. Feed pumps worked out according to Molesworth's rule and others always come out much too large—nearly three times. I shall be glad if some reader will explain this.—COLD WATER.

Replies.

☞ **Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.**

☞ **Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.**

A. ADAMS.—Several firms make such engines—Messrs. Bellis and Co., Birmingham, for example.

A. F. W.—Possibly Messrs. Aird and Lee, Broughton-road, Salford, will be able to assist you.

J. BRADLEY.—We would advise you to read "First Principles of Mechanical Engineering," 3s. 6d., which may be had from our office.

POINTS AND CROSSINGS.—"Railway Crossings," by W. H. Cole, price 6s., and "Railway Crossings," by W. Donaldson, price 10s. 6d., will suit your requirements, and may be obtained from our office.

LOCO.—The following are the safe loads in tons for crane chain:—$\frac{5}{16}$, $\frac{9}{16}$; $\frac{3}{8}$, $\frac{13}{16}$; $\frac{7}{16}$, $1\frac{1}{8}$; $\frac{1}{2}$, $1\frac{1}{2}$; $\frac{9}{16}$, $1\frac{7}{8}$; $\frac{5}{8}$, $2\frac{5}{16}$; $\frac{11}{16}$, $2\frac{13}{16}$; $\frac{3}{4}$, $3\frac{3}{8}$; $\frac{13}{16}$, $3\frac{15}{16}$; $\frac{7}{8}$, $4\frac{9}{16}$; $\frac{15}{16}$, $5\frac{1}{4}$; 1, 6; $1\frac{1}{16}$, 7; $1\frac{1}{8}$, $7\frac{5}{8}$; $1\frac{3}{16}$, $8\frac{1}{4}$; $1\frac{1}{4}$, $9\frac{3}{8}$; $1\frac{3}{8}$, $11\frac{5}{16}$; $1\frac{1}{2}$, $13\frac{1}{2}$.

H. BOURGEOIS.—(1.) The maximum number of revolutions of the wheels will, of course, depend upon their diameter. The circumferential speed should certainly not exceed 4000ft. per minute. (2.) About 1000ft. per minute is the usual limit of speed of drive chain. (3.) So far as we understand your last query, Yes.

APPRENTICE.—We do not see why the *area* of the valve seat need to be introduced into the calculation. Taking the lift of the valve (L), as Mr. Baird suggests, $= \frac{1}{4}$ its diameter d, then the speed through the valve will be $S = \frac{A \times R}{L \times \pi \times d}$, R being the speed of the ram, and A its area.

TUBE EXPANDER.—Do you refer to English makers? If so, there are only a few which you will find in Kelley's "Engineers' Directory." In the United States there are a large number, but we do not see how you are to obtain a list. We would advise you to consult the advertisement pages of such American journals as "Cassier's Magazine," "Power," etc.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

5th June, 1893.

10,859 THRUST BEARINGS for PROPELLER SHAFTS. F C Winby.

10,860 ARC LAMPS. W S and C R Boult.

10,861 WATER GAUGES. J Kershaw and W Gerlach.

10,864 PLANT for EVAPORATING BRINE. W A Kirkham.

10,869 LUBRICATORS.* E Whalley.

10,870 APPARATUS for COOLING, HEATING, or DRYING. F Fischer.

10,879 INSTANTANEOUS HEATING of WATER. J Hart.

10,884 MACHINERY for CLEANING and POLISHING SHEET-METAL BOXES or RECEPTACLES. J, T, and J Vicars, jun.

10,887 SYSTEM of TOWN SEWAGE DISPOSAL COMBINED WITH PRODUCTION of ELECTRICAL SUPPLY. W H Hill-Hartland.

10,888 TELEPHONE RECEIVER and TRANSMITTER. A E Muirhead.

10,895 DISTRIBUTING OIL UPON WATER from a SHIP. M Brooks.

10,896 MECHANICAL LUBRICATORS APPLICABLE for SIGHT FEED or DIRECT to the CYLINDER. J H Ingham and J Harwood, jun.

10,902 WATER or LIQUOR WASTE-PREVENTIVE VALVE WITH ANTI-PERCUSSIVE CLOSING MOTION and BOSS. R H Leaker.

10,904 RAILWAY SWITCH. G W Horne.

10,905 PROPS and FRAMEWORK for MINES. H C Barnes.

10,911 MACHINES for WASHING, SCRUBBING, RINSING, CLEANING, and DRAINING BOTTLES. R Finlayson.

10,912 BATTERY STAMPS for CRUSHING ORE. G C Marks. (*A M Brown and G C Fox, South Africa.*)

10,913 HEATING and VENTILATING SYSTEMS. F Ashwell and D M Nesbit.

10,915 Crushing, Pulverising, and Disintegrating Machines. A L Smith.
10,916 Wood-working Machinery for Planing and Moulding. W Illingworth and J W Haywood.
10,937 Electric Meter. A H Howard.
10,912 Primary Voltaic Batteries. W Walker, jun, and F R Wilkins.
10,945 Manufacturing Copper or other Metal Bends for Forming Tubes. A McDiarmid.
10,945 Method for Coupling and Uncoupling Railway Wagons. B R Leppard.
10,951 Motor. W and T Slater.
10,953 Water Motor. W Smith.
10,951 Cycles. B Hallett.
10,963 Electro-mechanical Switch and System of Electrical Inter-communication.* E A Clark.
10,965 Insulating Compounds. E T Hughes. (*M H Devey, United States.*)
10,966 Locking Device for Railway Carriage Doors. E T Hughes. (*W H Haley, United States.*)
10,981 Disc Engines Suitable as Water Meters. W G Kent.
10,987 Electric Propulsion of Boats. F R Brown.
10,990 Type-composing Machines. P Jensen. (*W P E Beck, Germany.*)

6th June, 1893.

11,004 Steamship Propeller. T Williams.
11,015 Manufacture of Gas for Illuminating and Heating Purposes. H, E, and H Spicer.
11,016 Boiler Furnaces. E Storrs.
11,017 Wheels for Vehicles. J H Ball.
11,018 Driving Chains. P Burdett.
11,019 Gibson's Mineral Bleaching Apparatus.* E Gibson.
11,028 Mode of Producing a Circular Motion by Movements of Combined Levers Moving in Straight Rectangular Lines, applicable to Engines and Machinery. G Chapman.
11,030 Brakes for Railway and other Vehicles. J S Highfield.
11,033 Steam Boilers.* C C Peck.
11,050 Wheels. W S Rawson and J Bonn.
11,052 Thermostatic Instruments. A G Brookes. (*G W Gregory, United States.*)
11,057 Screw Lifting Jacks. G Tangye.
11,069 Producing (or Maintaining) Continuous Lines of Telegraph Wires, Rails, and Pipes.* W P Thompson. (*E E Ries and A H Henderson, United States.*)
11,071 Devices for Fastening Cams, Pulleys and the like to Shafts.* P M Justice. (*E A Branton, jun, United States.*)
11,072 Valves.* A A Fisher.
11,077 Automatic Circuit Breaker.* C Peterson.
11,079 Machinery for Making Paper Bags. C Anderson.
11,084 Arc Electric Lamps. S S Allin.
11,086 Indication of Release of Load on Hoisting Machinery specially suitable for the Cages in Mining Shafts. H Sinning and K Brandau.
11,092 Electric Batteries.* M L M Hellesen.
11.095 Ornamenting Wooden Surfaces. W M Taylor.
11,097 Apparatus for Supplying Locomotive Tenders with Water.* J Y Johnson. (*The Automatic Water Tank Company, United States.*)
11,096 Railway Couplings. L S Manning.
11,099 Electric Glow Lamps.* H H Lake. (*E A Colby, United States.*)
11,100 Middlings Purifiers.* H Seck.
11.102 Screw-making Machines.* B F Wheeler.
11,103 Generation of Heat by the Combustion of Fuel.* W L Teter and H L Webster.
11,104 Evaporating Apparatus.* S M Lillie.
11,105 Electrolytic Apparatus.* T Craney.
11,106 Electrolytic Cells.* T Craney.
11,107 Electrolytic Apparatus.* T Craney.
11.119 Stern-wheel-propelled Vessels.* R J Hammond.
11,120 Paddle Wheels.* R J Hammond.

7th June, 1893.

11,127 Lock Nuts. J R Peacock.
11,132 Nozzle in connection with Gas Engines. W Anyon.
11,138 Gas Engines. G A Jarvis.
11,139 Steam Generators. G H Herbert and A Marr.
11,141 Joint Flanges of Pipes or Tubes. J Dick, jun.
11,143 Electrical Switches, Fuses, Ceiling Plates, etc.* C M Dorman and R A Smith.
11,144 High-pressure Steam and Water Flange Jointing. J J Rogers and A E Mills.
11,148 Wrench. W Bill.
11.149 Velometer.* V Canrobert and W D Welford.
11,154 Apparatus for Finishing the Edges of the Soles and Heels of Boots and Shoes. S J Pegg.
11,155 Agricultural Drills. J L and L B Ashurst.
11,163 Apparatus applicable for the Propulsion, Raising, and Lowering, etc., of any Vessel in the Air and Water. E Garnier.
11,166 Obviating the Dead Centres in Steam Engines. W Knapp.
11,168 Arc Lamps. B Death.
11,169 Metallic Packing for Piston Rods. G Garnett.
11,172 Regulating the Draught in Locomotive Smoke Stacks. F Strattner.
11,176 Electrical Indicators. J T Gent and others.
11,177 Fittings for Electric Glow Lamps. P Ward and E Cooper.
11,180 Cable Railway or Tramway. J B Smithman.
11,182 Amalgamating Apparatus to be Employed either alone or in combination with Concentrating Apparatus or Buddles. W A Green.
11,183 Grapnels for Submarine Cables. W C Johnson.
11,184 Apparatus for Effecting Electrical Communication between a Number of Separate Stations or Apartments with a Central Station or Apartment. Siemens Bros. and Co. Limited. (*F E Morgan and H E Walter, United States.*)
11,185 Gas Meters. W E Price.
11,187 Posts and Railways. J Parker.
11,189 Glass-cutting Device. A J Randell.

8th June, 1893.

7542A Sifting or Separating Machines. S Edwards.
11,205 Revolving Spiral-shaped Screw for Aerial Machines. D Graham.
11,207 Machinery for Evaporating Petroleum and Hydrocarbon Mixtures. G V Priestley.
11,208 Tramcars. H Johnson.
11,217 Drilling Machines. A Herbert.
11,235 Electric Motor Fans. J A Wade.
11,236 Pulley Blocks and Hoists. R Priest and W Morrall.
11,237 Machinery for Cutting-up Card Board for Forming Circular Boxes. L Myers and C B Ketley.
11,239 Apparatus for Making Branch Connections to Main Pipes while Fluid Pressure is in such Main Pipes. J T Towlson.
11,242 Motor.* J Griffin.
11,243 Grinding Attachments for Lathes.* A G Brookes. (*C D Fuller, United States.*)
11,249 Machines for Syruping and Filling Bottles with Aerated Liquids. J McEwen.
11,253 Apparatus for Lessening the Force of Impact of Falling Bodies. G M Hamlyn.
11,255 Machines for Carving Wood. T Ryland.
11,257 Taps. D C M Fitzmaurice.
11,259 Automatic Winding Mechanism applicable to all kinds of Clockwork. J P Humbrecht.
11,272 Treatment of Waste from Leather Manufactories. J Bergmann.
11,277 Gear for Reversing and Speeding Tramcars and other Locomotives. H P Holt.
11,281 Lining Ladles intended to contain Molten Metal or Metallic Alloy. W Galbraith.
11,282 Appliances for Effecting the Rocking Motion of Cradles, etc. J Hounsell.
11,289 Water Meters. W Curle.
11,294 Automatic Electric Exchange. R Pippette.
11,296 Automatic Clutch or Frictional Brake. W H Payne-Gallivey and others.
11.298 Sight-feed Lubricator. J A and J Hopkinson.
11,299 Electro-magnetic Machine. M R von Léon.

9th June, 1893.

11,307 Rest-stay or Drill Holder for Lathes. A Adams and J Barlow.
11,312 Automatic Couplings for Railway Wagons. A Rushforth.
11,315 Cranes and other Lifting Machinery. H J Coles.
11,323 Safety Hook or Coupling. J Eley.
11,331 Fans. H B Daglish.
11,332 Lubricating Pitch Chains and Sprocket Wheels. C Keizer.
11,339 Steam Engines and Steam Pumps.* H B and J S Watson.
11,348 Water Gauge for Steam Boilers. C McLaren.
11,359 Railway Signalling. E Y Walsh.
11,369 Insulating Compound and Process of Preparing same.* A G J Goldschmidt and E R von Scanavi.
11,373 Steering Mechanism for Boats.* J P Holland.
11,374 Coupling for Rods, Tubes, Ropes, etc. A Thomson.
11,375 Hold-fast Anchor. I A Cawley.
11,379 Aluminium Tannico-tartaricum.* J Wetter. (*The firm of J D Riedel, Germany.*)
11,384 Apparatus for Regulating the Electro-motive Force of Electrical Generators. J S Raworth.
11,387 Microphones. Sir C S Forbes, Bart.
11,388 Registering Mechanism for Recording the Loads Raised and Delivered by a Crane in Discharging Cargoes from Lighters. W Rahtz.

10th June, 1893.

11,391 Electromotors and Dynamo Electric Machines. R Shepherd.
11,395 Effecting Complete Combustion in Furnaces. W Bracewell.
11,407 Gas and Oil Motor Engines. F W Lanchester.
11,409 Weighing Machinery. J S Pooley.
11,411 Scale for use of Architects and Draughtsmen. T G Worbey.
11,413 Machines for Drawing Metals.* H Dollman.
11,417 Triangular Aqueducts to Expedite the Speed of Ocean Steamers. M F Gallagher.
11,420 Hollow Cylinders composed of Metallic Strips. T A Judge.
11,426 Electric Motor. H L Todd and G Lewis.
11,427 Electric Accumulators or Secondary Batteries. J C Howell and others.
11,442 Furnace. R Dempster.

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BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

*** Where the numeral is absent, the Advertisement does not appear this week.

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FRIDAY, JUNE 30TH, 1893.

The Loss of the "Victoria."

THE terrible disaster which occurred on Thursday last week, when the battleship "Victoria" sank after colliding with the "Camperdown" off the Syrian coast, will probably modify to some extent the present theory of the value of watertight compartments, while it will also direct attention to the very serious results attending failure of the steering gear of our ironclads. The terrible execution wrought by the ram of the "Camperdown" proves only too well how effective is this mode of attack when battleships are in close quarters; but it also shows equally well how vulnerable is the latest type of war vessel. Those who favour the extended employment of the armoured cruiser in place of the huge and costly ironclad, can, with much show of reason, adduce the loss of the "Victoria" as a further argument in favour of their contention.

Electric Traction Powers.

IN our issue of the 9th inst. it was mentioned that a Parliamentary Committee would shortly meet to consider the very important question as to whether, to put it briefly, the telephone interests should be protected or not against any disturbing influences which might be set up by the operation of electric tramways. That Committee, consisting of members of both the House of Commons and the House of Lords, met last and this week under the presidency of Viscount Cross, and by the time the present number of this journal is in the hands of our readers, the labours of the Committee, in so far as receiving evidence and hearing counsel for the different interests are concerned, will practically be at an end. In fact, nearly the whole of the evidence was disposed of by Friday afternoon, and on Monday witnesses were heard on behalf of the gas and water interests, this—with the exception of the addresses of counsel, proceeding this week—terminating the proceedings prior to the drawing up of a report or the drafting of a bill to legislate on the subject. Having carefully listened to the lengthy evidence given on all sides, we must admit that the question has assumed wider proportions than was supposed; and the inquiry is by far the most important since that held in 1888 to consider electric lighting. It will be interesting to briefly summarise the salient points. In the first instance, let us consider telephony. The National Telephone Company, with the exception of a small percentage carried on by the Post Office Department, practically has a monopoly of the telephone business in the United Kingdom; the method used is generally the single-wire system, with earth return or return formed by the gas and water pipes. The directors consider that the earth return is sufficient for all purposes where subscribers can be concentrated in a central exchange, and that the introduction of a metallic return would necessitate a rearrangement of the whole telephone system, at considerable expense. The telephone company urge that electric tramway companies, owing to leakage and induction, should be compelled to use an insulated return conductor as well as an insulated outgoing conductor, and that thereby the telephones would be protected from interference. Evidence was adduced to endeavour to prove this view of the matter. On the other hand, the advocates of electric traction submit that the telephone service is defective, that all interference caused in telephones is due to the use of the single-wire system, and that the cost of transforming that method into a complete metallic-return system would not necessitate great expense. It is, moreover, urged that the effect of the telephone company's protective clause—the substance of which was given on the 9th inst.—has been to practically put a stop to electric traction in this country, and that since the insertion of that clause in various Acts and provisional orders there has been no advance in electric traction on tramways. Evidence was given showing that the protective clause had had the effect of preventing those who desired to adopt electric traction, from doing so. Furthermore, it was practically agreed by experts, on behalf of electric traction, that it was absolutely impossible to design a system of electric tramway which would be certain not to interfere with telephones either by leakage or induction, the latter being the most serious cause of disturbance in telephones. Traction by accumulators not being considered a commercial possibility, the methods suggested to be used in this country are the single-trolley system as at Leeds, a slot or open-conduit method, or a closed-conduit system, if one should prove workable. The railway companies, as shown by evidence, want their signal and other wires protected from the working current of tramways, so as to prevent disturbances and ensure the safety of the travelling public. On the lines of the Midland and London and North-Western Railways at Walsall, the operation of the electric tramway in that town has interfered with the signals, but by duplicating the wires the difficulty has been overcome. It is urged in tramway interests that the railways should use complete metallic returns, and that by doing so no interference could take place. It is further submitted that very shortly competition in telephony will compel the telephone company to adopt metallic returns, and that apart from electric traction; the development of electric lighting will oblige the railway companies to use a complete metallic circuit. Gas and water companies are concerned mainly as to the possibility of electrolytic action on their pipes, due to leakage; but as far as regards electric traction, it is suggested that before such pipes could be eaten away by escaping tramway currents, the rails forming the return circuit of the tramway would have to be worn out by the same action several times over; hence tramway companies in their own interests would see that very little leakage would occur, and, therefore, no pipes would be damaged. We close this brief summary of the position; any comments on the evidence would at present be out of place.

Dredging in a Frozen River.

DURING last winter a novel use was made of a steam shovel in excavating the bed of the Red River, near Winnipeg, for three piers of a bridge, the ice on the river being 2½ft. thick. An ordinary railroad track was laid over the ice to within 30ft. of a hole 22ft. by 60ft. cut in the ice over the proposed location of the first pier, and then heavy sleepers, some 10in. wide and 50ft. long, were laid for the rest of the distance. The steam shovel was then run over this track to within 6in. of the edge of the hole, and there securely anchored with blocks and chains and put to work. The material excavated was discharged from the bucket upon sleds and hauled away.

Corrosion of Pipes.

ONE of the questions with which the Joint Parliamentary Committee on Electric Powers Protection Clauses, already referred to, has to deal with, is that of electrolytic action on gas and water pipes. It is doubtful whether this point would have arisen had it not been for remarks made at the first sitting by Sir Courtenay Boyle, of the Board of Trade, and Mr. W. H. Preece, of the Post Office; and their statements, as Mr. S. Pope, Q.C., said on the following day, had considerably alarmed the gas and water companies. We think they were needlessly alarmed. Taking the ordinary case in the United States, where the negative pole of the dynamo is connected to the trolley and the positive to the rails, it is not surprising that serious electrolytic corrosion of water pipes has taken place in that country. By reversing the connections—that is, putting the positive to the trolley and the negative to the rails,—the electrolytic action is considerably diminished, and the rails must be worn out several times over before any pipes can be affected. In electric lighting, too, experience in the metropolis shows that when the proper pole of the generating system is connected to earth, there is little chance of electrolytic action on the pipes. Still, more may yet have to be said on the matter.

Railway Rolling Stock in the Argentine Republic.

ENGLISH makers of rolling stock do not show up to advantage in the report of the Department of Engineers of Buenos Ayres on the rolling stock of the Southern and Western Railroads of the Argentine Republic. The inspecting engineers of the department say that the whole of the rolling stock of the Great Southern Railway is of English construction, sufficiently solid and of good material, but in designing it the nature of the railroads has been absolutely left out of consideration; consequently, it possesses extreme rigidity and excessive weight, completely unfitting the rolling stock for the roads over which it is to run. The result is said to be an excessive expenditure in the maintenance of way and rolling stock. Moreover, the cost of the English rolling stock is said to be unreasonably high. On the Western Railroad the locomotives are from the United States, and are said to be simple in construction, but "of the highest order." Although severely taxed in consequence of the deficient number of locomotives, they gave satisfactory results in all respects. In general, the verdict of the department is altogether in favour of North American rolling stock, because of greater simplicity, less weight, and better system of suspension. First cost and cost of maintenance are lower than with European rolling stock, and in the American passenger cars the deadweight per passenger is said to be about half that of the English-built coaches. Judging from this report, the Americans appear to be altogether beating us in neutral markets—at least, so far as railway rolling stock is concerned.

Tests for Indiarubber.

A RUSSIAN naval officer has recently carried out a series of tests at the St. Petersburg Technical Institute with a view to establishing rules for estimating the quality of vulcanised indiarubber. The following, in brief, are the conclusions arrived at, recourse being had to physical properties, since chemical analysis did not give any reliable result:—1. Indiarubber should not give the least sign of superficial cracking when bent to an angle of 180° after five hours of exposure in a closed air bath to a temperature of 125° C. The test pieces should be 2·4in. thick. 2. Rubber that does not contain more than half its weight of metallic oxides should stretch to five times its length without breaking. 3. Rubber free from all foreign matter, except the sulphur used in vulcanising it, should stretch to at least seven times its length without rupture. 4. The extension measured immediately after rupture should not exceed 12 per cent. of the original length, with given dimensions. 5. Suppleness may be determined by measuring the percentage of ash formed in incineration. This may form the basis for deciding between different grades of rubber for certain purposes. 6. Vulcanised rubber should not harden under cold. These rules have been adopted for the Russian navy.

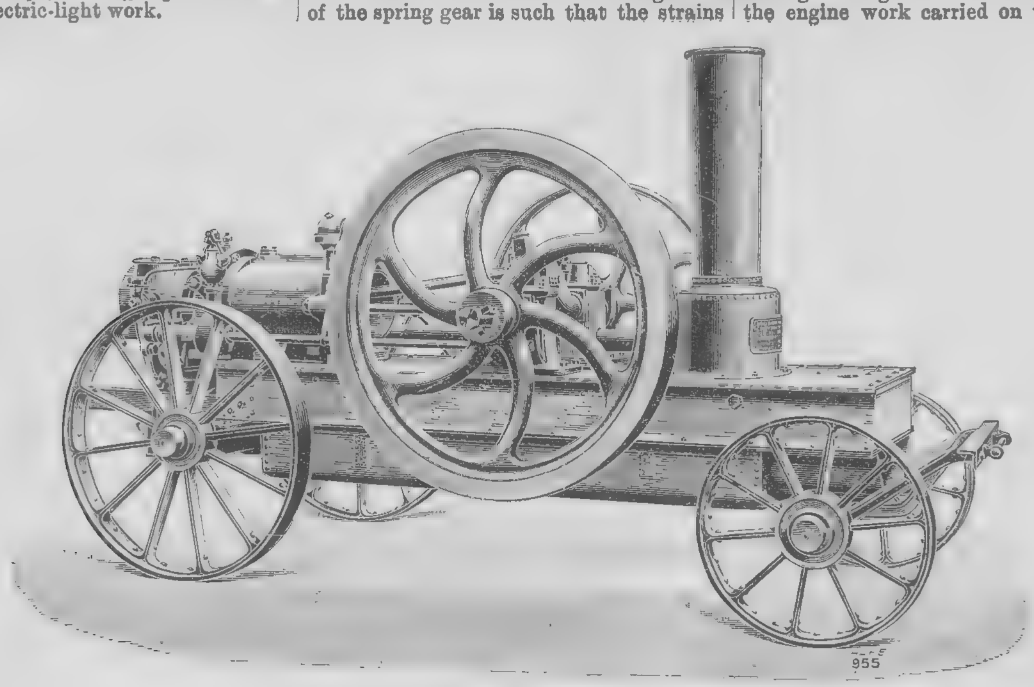
The Royal Agricultural Society's Show at Chester.

THE fifty-fourth annual show of the Royal Agricultural Society was this year held at Chester, from the 17th to the 23rd inst. The show ground, which covered nearly 100 acres, was situated in the suburb of Hoole, a fine stretch of meadows about a mile from the railway station being utilised for the purpose. Over 13,000ft. of shedding was erected, as compared with 12,511 at Warwick, 12,473 at Doncaster, 9078 at Plymouth, 15,602 at Windsor, 10,743 at Nottingham, and 8217 at Newcastle. In all, 5527 exhibits had been entered.

Usually the society has offered premiums for machines specially useful in the district in which the show happens to be held, but this year the practice has not been followed strictly, the special premiums offered this time being for harvesters and sheep-shearing machines. For the former, three prizes of £50, £30, and £20, will be given, and the trials will take place during the coming harvest. The competition is for self-binding harvesters using other binding material than wire, and in considering the merits of the various machines the judges will specially direct their attention to cost, simplicity of construction, draught, time, weight in reference to draught, clean work and freedom from waste, easy handling, good sheafing, efficient binding, and the quality and cost of binding materials. For this competition twenty-three entries have been made.

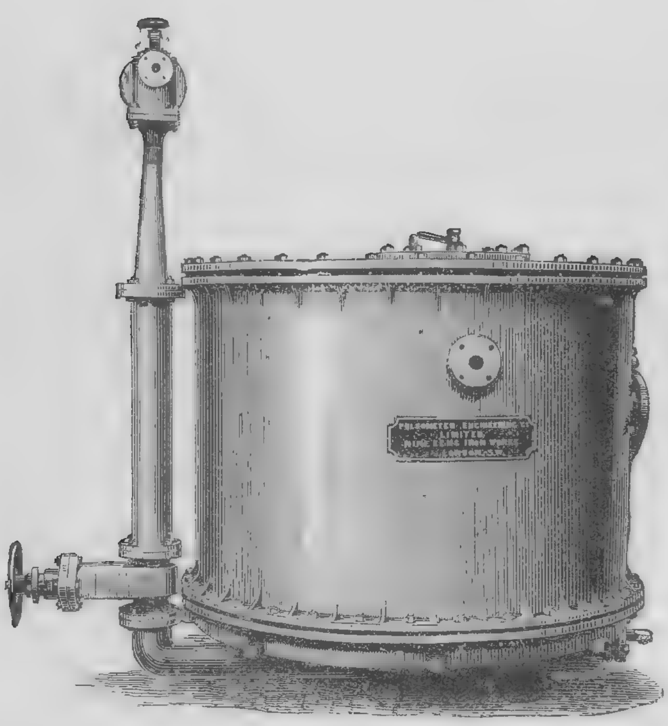
Generally speaking, there were very few novelties to be found in the implement yard, and progress is for the most part indicated by improvement in detail rather than by any striking departure either in design or construction. As usual, Messrs. Robey and Co. had on view a large number of their well-finished engines, including their horizontal steam engine fitted with patent automatic trip-expansion gear, suitable for heavy work and provided with a high-class expansion gear for securing economy in fuel. This firm claim to have produced in their patent trip-expansion gear the most satisfactory governor hitherto made. Messrs. Robey's compound Robey engine and locomotive boiler combined, fitted with patent automatic governor and link-expansion gear, specially

suitable for driving electric-light installations, mills, factories, and other machinery where steady running is required, was also shown. In addition to the above, Messrs. Robey and Co. exhibited specimens of their medium and long-stroke horizontal fixed engines fitted with their patent automatic governor and link-expansion gear; likewise their portable engines and wrought angle-iron-framed thrashing and finishing machines, steel-framed stone breakers, centrifugal pumps, and high-speed vertical engine for electric-light work.

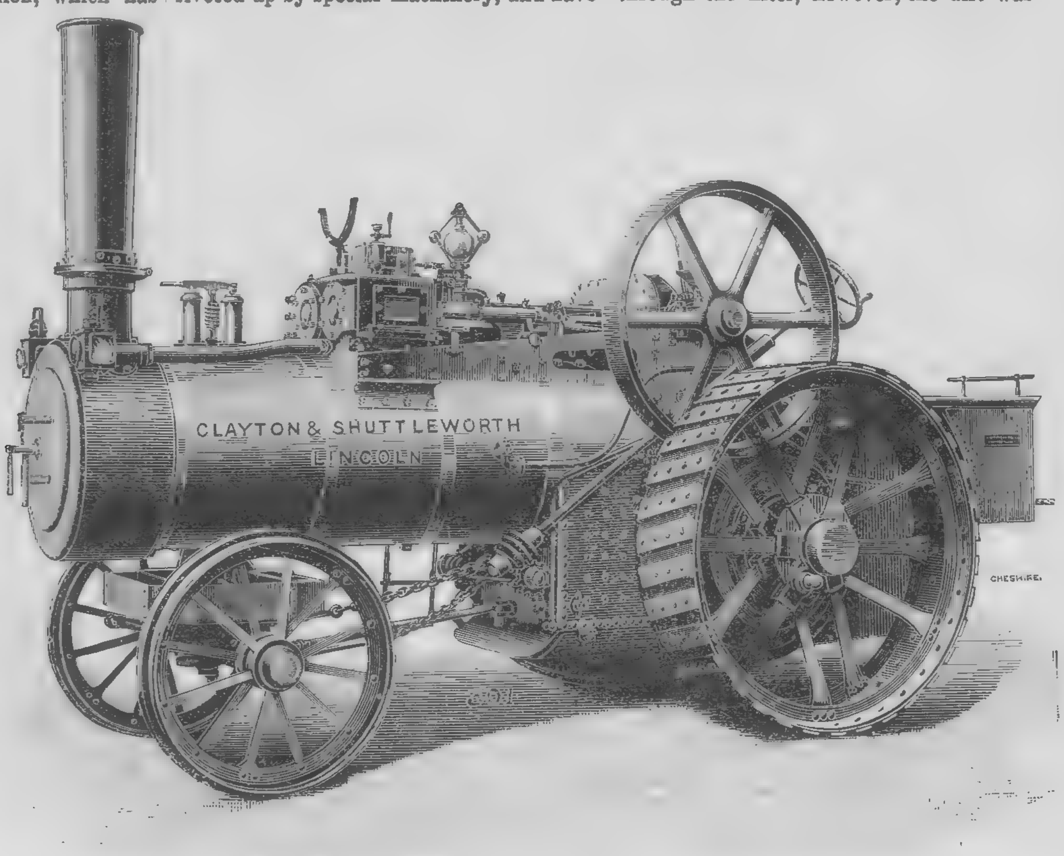


12½H.P. Hornsby-Akroyd Oil Engine.—Fig. 1.

Messrs. Ransomes, Sims and Jefferies, Ipswich, exhibited specimens of their new 6 and 8H.P. traction engines, of which we gave an illustrated description in our account of the Warwick Show. The gearing throughout is of crucible cast steel, and the fast and slow speeds are arranged between the bearings to economise space. All the bearings are fitted into bored holes in the side plates of the firebox shell, which are carried upwards and backwards for the purpose. A channel-iron draft bar is provided, which extends across the back of the tender, with deep straps welded on each side, which take the pull from the horn plates and relieve the tender from all hauling strains; a series of holes is provided in the draft bar, so that the draft pins can be moved out of the centre when required for turning sharp corners with a long train. Specimens of 6 and 8H.P. portable engines were also shown, and these have large steam-jacketed cylinders, wrought-iron crankshaft brackets, round-top fireboxes, and piston-valve governors. Messrs. Ransomes' 4H.P. vertical engine is connected with their patent multitubular vertical boiler.



Torrent Filter.—Fig. 2.



Clayton and Shuttleworth's Double-cylinder Traction Engine.—Fig. 3.

Messrs. John Fowler and Co., Leeds, had a large display of engines for ploughing, haulage, electric lighting and other purposes; and also a number of models of their patent light railway plant and rolling stock. Of the engines exhibited by this firm, one has been entered in the competition for the Royal Agricultural Society's medal. This is a single-cylinder road locomotive of the Class B type, mounted on spring gear, which has been specially designed for constant road work. The arrangement of the spring gear is such that the strains are always in one direction, thus avoiding knocking after wear has taken place. A laminated twin spring carries the weight of the hind part of the engine, and it is regulated by one central suspension bolt, ensuring equal adjustment. Compensating levers are fitted for the purpose of keeping the shafts constantly parallel, while allowing free vertical movement due to the action of the spring and equalising the strains on the bearings. A novel driving plate is fitted between the third motion wheel and road spur pinion, which has large surfaces and gives the necessary latitude for springing, the gearing constantly running true on the pitch circles. The front end of the engine is carried on a novel arrangement of spring fore carriage, which allows a free movement of the front wheels in every direction, and gives a uniform strain on each end of the spring. In spring gear of this type, up to now there has always been considerable wear and tear occasioned either by the shafts not moving parallel with each other or in consequence of the strains acting backwards and forwards alternately, which occasions knocking and play in the joints and bearings. By the gear in this engine, this difficulty is overcome by the equalising or compensating levers, by which the arms connecting the shafts are always in tension, and the shafts are always moving parallel to each other. An 8H.P. semi-portable engine, specially constructed for electric lighting, also attracted some attention.

Messrs. Marshall, Sons and Co., Gainsborough, exhibited at their stand a 16H.P. portable engine on flush-top boiler, with sliding carriages for the crankshaft, and the engine work carried on wrought-iron stays, entirely independent of the boiler. This engine is suitable for working at 90lb. steam pressure, and is suitable for builders' and contractors' work. This firm also exhibited a 7H.P. portable engine, provided with enlarged firebox for burning inferior coal as fuel, and made with wrought-iron crankshafts, carriages, diagonal force pump, etc. Several 6 and 8H.P. traction engines were shown which embody many important improvements. The travelling wheels are of extra strength, riveted up by special machinery, and have recently been increased in size. The boilers are also enlarged, giving greater heating surface. The side plates of the boilers are now carried up to form the horn plates, the sizes of the axles and countershafts have been increased, and every attention paid to the lubrication so as to make the engine as simple and efficient as possible. Two thrashing machines, 4ft. 6in. wide, were shown, one with a 20in. and the other with a 22in. drum, and both of the finishing class. They are fitted with extra large riddling and dressing surfaces and all the most modern appliances for thrashing and preparing the grain for market at one operation. For carrying the straw away from either of these thrashing machines a 25ft. stacking machine or straw elevator, with turnover carrying trough, was exhibited.

In addition to their exhibit of traction, portable, and vertical steam engines, finishing and thrashing machines, etc., Messrs. R. Hornsby and Sons, Grantham, had on view six Hornsby-Akroyd oil engines, the sizes ranging from 1½ to 16 brake horse-power. A portable oil engine of about 12½H.P., driving a thrashing machine, was also exhibited. This engine, which is Messrs. Hornsby's latest design, is shown in Fig. 1. The engine is mounted on a channel-iron frame having a wrought-iron box or tank suspended underneath it. Instead of the usual arrangement of having a large tank full of water for cooling the cylinder, only a small quantity is used, which is pumped through the cylinder jacket and then allowed to run down a series of trays placed inside the box or tank, a current of cold air being drawn by the action of the blast caused by the exhaust in the chimney through openings in the tank and over the trays on which the water runs down. This engine is suitable for driving a 4ft. or 4ft. 6in. thrashing machine, saw tables cutting 12in. timber, pumping, driving an electric-light dynamo, or, indeed, for any of the various purposes for which a portable steam engine is usually employed.

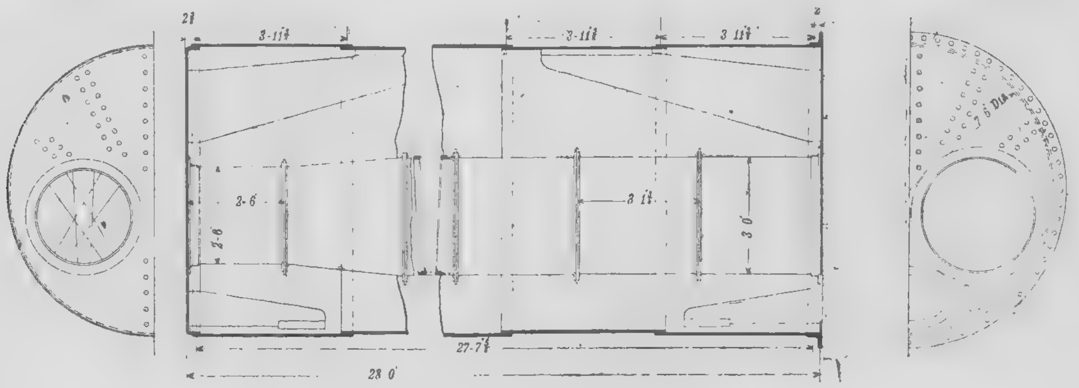
Mr. E. S. Hindley, Queen Victoria street, London, exhibited a large number of small steam engines in which some improvements in detail have recently been made. We noticed at this stand a small friction-driven sack hoist, which was exceedingly simple and effective. The arrangement necessitated the use of one lever only for raising, lowering, and stopping.

A noticeable exhibit was that of the Pulsometer Engineering Company Limited, at whose stand a number of Pulsometers were shown. A No. 5 Pulsometer, fitted with the "Grel" cut-off arrangement, which allows the steam to be worked expansively, was shown at work, as was also a Torrent filter (Fig. 2), capable of purifying 1000gals. per hour. We may say that the water entering the filter was most heavily charged with dirt, and apparently unfit for manufacturing or other purposes. During its passage through the filter, however, the dirt was completely separated from it, causing it to reappear as bright and sparkling as one could wish. This firm also exhibited a "Deane" sinking pump, suitable for raising about 3300gals. per hour from a well or shaft 200 or 300ft. deep. We may state that the rods which are used to suspend the pump, taking weight off joints, were invented and introduced by the Pulsometer Engineering Company, since when their merits have been freely recognised. The other pump exhibits included a "Caryl" fly-wheel pump, a marine duplex, etc. One of the company's chief exhibits, however, must not be forgotten. We

allude to the ice-making machine. The little machine shown is very compact and simple, occupying a space of only 8ft. 6in. by 6ft. by 3ft., and will make 10cwt. of ice per 24 hours. It is especially suitable for dairies, hotels, small cold rooms, etc., on land and aboard ship.

Messrs. Clayton and Shuttleworth, Lincoln, had on view a number of their engines, the principal novelty being the double-cylinder traction engine, shown in Fig. 3. The boiler is of steel, stayed in a somewhat similar manner to ordinary locomotive boilers. The crankshaft and toothed gearing are of extra strength, and all the levers and handles are within easy reach of the driver. The engine is provided with a draw-back lug at the front end for the engine pulling backwards. It can also be fitted with a winding drum for drawing machines out of places inaccessible to the engine, or up hills so steep that the engine has first to be taken up alone and then the winding drum and rope used to pull up the load while the engine remains stationary.

(To be continued.)



Practical Hints to Boilermakers.—Fig. 1.

Practical Hints to Boilermakers and Templaters.—II.

By a Foreman Boilermaker.

We will now proceed as in the workshop. The templater, when he receives his tracing, should examine it thoroughly, and if found all correct he should at once proceed to work. He should first consider the length and diameter of the boiler, which in this case is 28ft. long by 7ft. 6in. diameter. The number of belts in the shell is seven, the back end being flanged, and the front end fixed with an angle ring, as shown in Fig. 1. The first proceeding is to deduct the space between the first rivet centres and the ends of the boiler, which is $2\frac{3}{8}$in. + 2in. = $4\frac{3}{8}$in., and $4\frac{3}{8}$in. − 28ft. = 27ft. $7\frac{5}{8}$in. Then 27ft. $7\frac{5}{8}$in. ÷ 7 = 3ft. $11\frac{3}{8}$in.—*i.e.*, seven widths of 3ft. $11\frac{3}{8}$in. each would be the rivet centres, and, with $4\frac{3}{8}$in. added, would make up 28ft., the length of the boiler.

The templater would now find the circumference of the diameter, which is 7ft. 6in. mean diameter — *i.e.*, the outside of the inside belt would be 7ft. 6in., and the inside of the outside belt would be 7ft. 6in. Therefore 7ft. $6\frac{1}{2}$in. would be the mean diameter of the outside belt, and from this the calculation must be made. 7ft. $6\frac{1}{2}$in., or 90·5in. × 3·1416 = 284·31480, or 23ft. $8\frac{5}{16}$in., the total circumference of outside belt. The inside belt for a good working fit would be six-and-a-half times its own thickness less, or 23ft. $8\frac{5}{16}$in. − $3\frac{1}{4}$in. = 23ft. $5\frac{1}{16}$in., to which must be added the amount of lap required, which for single riveting would be $2\frac{1}{2}$in., and for double riveting $4\frac{3}{8}$in.

The templater should now get his plate laid on to a good flat surface and proceed to strike out his lines in the manner indicated by the annexed sketch Fig. 2, which will greatly assist the beginner to do it for himself should the opportunity occur.

Draw the line B through the centre of the plate to its full length, and from B draw the lines A and C to the given distance—3ft. $11\frac{3}{8}$in.; and from any convenient point on the line B draw the arc, cutting the line A and C at D D, and from D D to E E measure off the circumferential length, which is 23ft. $8\frac{5}{16}$in. Next add the lap, which is $1\frac{1}{4}$in. all round, and mark it for planing; the plate is then ready for setting out. The templater would be wise not to divide the whole length with the compasses, but to divide it into three or six portions; and that is done very conveniently by having a strip of flat iron $2\frac{1}{2}$in. by $\frac{1}{8}$in., one-half the length of the plate, divided into three parts, and carefully set out, stamped, and drilled with small holes. This can be clamped on to the plate, and the holes stamped through with a nipple centre-pop, and shifted along to the remaining half of the plate, and so on. An inside strip, together with a longitudinal strip, completes the shell templates, which, when the job is finished, should be stamped and laid by for further use. Most good boilermakers have pitched machines, and the plates do not require to be popped, except for the tacking holes, which are drilled and cleaned before being rolled up, and should be six or nine in number. Care should be taken to keep the centre top hole good throughout the entire length of the boiler, and the longitudinal joints well up from the brickwork and clear of the gusset stay bars. The gusset stay bars are best marked on after the plates are rolled up and two of the belts bolted together; then there is no fear of blundering. The standard pitch is 3in. The single web of the angle stay bars should be set to the radius of the boiler shell and bolted together with temporary plates of the same thickness as the stay plate, fixed to the shell with tack bolts, and drilled in position. The whole shell, when drilled, should be taken asunder, the burrs carefully taken off and properly cleaned, otherwise a good job cannot be expected. The sketch Fig. 3 of a burr-cleaning tool will explain itself. It cuts both sides at one operation, the cutting edges being A and B.

A full-sized sheet-iron template should be made for one half of the boiler front, as shown in the sketch, and all the holes marked on the plate, a sufficient number of tacking holes being drilled to hold the angle ring and gusset stay bars. The distance from the top and sides of flues to the first rivet in the gusset bars should be not less than 7in. on the front end, and not more than 10in. on the back end. The same template should be doubly marked, and should mark both ends. This also, when the job is finished, should be properly stamped and laid aside for further use. When a series of these templates are made to standard sizes, the work of setting out in a land shop becomes wonderfully easy, and is confined mostly to one man in each shop; hence one of the reasons why so very few ever have the opportunity of even seeing how templating is done.

The flue is made up of seven parallel rings 36in. external diameter, one tapered length, and one length for the back end reduced to 30in. external diameter. The flues should be right and left-handed—*i.e.*, there should be a short length on opposite ends, so that the combs of the joints may not foul each other. The back-end length should be the making-up one, and its length should never be decided until the other parts are finished, when the flue can then be made of a length corresponding to that of the shell. Care should be taken that the centres on each end of the flue hang plumb to each other, otherwise, when shelled, they may be a cause of trouble.

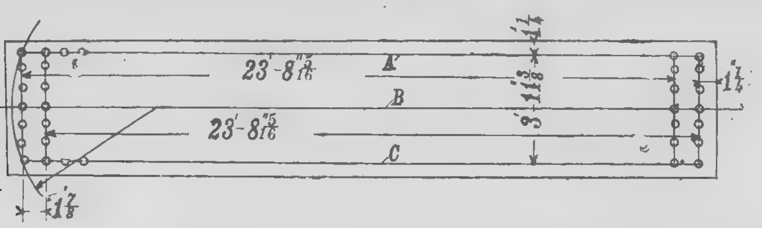


Fig. 2.—Practical Hints to Boilermakers.

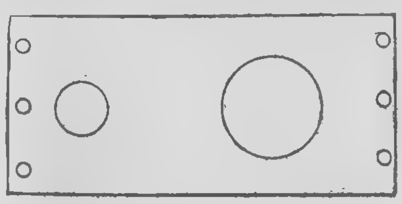


Fig. 4.

The most common way of preparing the rings for welding is as follows:—The external diameter being 36in., the mean diameter would be $35\frac{9}{16}$in., or 9ft. $3\frac{3}{4}$in. circumference, to which is added three times its own thickness — that is, $1\frac{1}{4}$in. for welding, or 9ft. 5in. in all. The length of the ring when finished is 3ft. $1\frac{3}{4}$in., and $2\frac{1}{2}$in. added to each side for flanging would give 3ft. $6\frac{3}{4}$in. Therefore, the size of plate required to make the ring would be 9ft. 5in. by 3ft. $6\frac{3}{4}$in. These plates are generally ordered of the exact size, so that it is usual in the works to apply the common square and adjust them with a length rod. Three holes are punched on each end (see Fig. 4) for service rivets to hold the ends in position while being welded, which is done in five or six heats. One end is next scarfed on the planing machine, when it is taken to the bending rollers, and the other end hammered down (see Fig. 5). It is then rolled up to a circle; the three rivets, which should be of iron, are put in, and it is ready for welding (see Fig. 6).

(To be continued.)

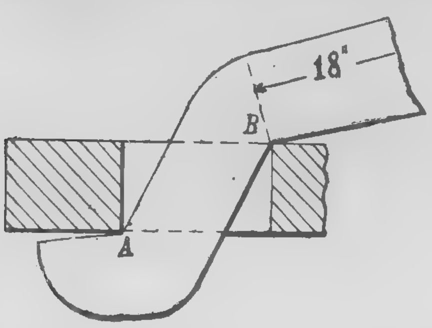


Fig. 3.

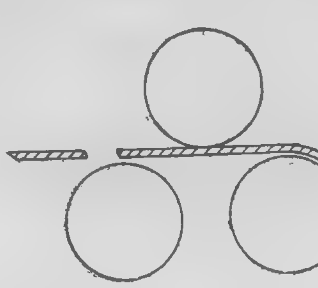


Fig. 5.

Practical Hints to Boilermakers.

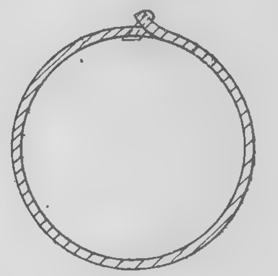


Fig. 6.

Mechanical and Engineering Drawing.—XIV.

By a Practical Draughtsman.

The Projection of Solids.—Assuming that the student has followed the advice given in the last paragraph of Article XIII., and thoroughly mastered the elementary principles of projection which we have expounded in it and Article XII., we can now proceed to apply those principles to the delineation of the simple geometrical solids of which engine and machine details are invariably made up. These solids are of two kinds—viz., plane, and circular or curved. The first-named have all their surfaces plane figures, the projections of which the student already knows how to obtain, and the second includes all solids whose bounding surfaces are all curved, or plane and curved combined. What are known as the simple solids are the cube, the prism, the pyramid, the cylinder, the cone, and the sphere, the first three being *plane* solids, and the others *circular* or curved solids.

A *cube* (Fig. 89) is a solid having six equal sides or faces, all of them squares.

A *prism* (Fig. 90) has two ends or bases parallel to each other, each being equal and similar figures; its sides are rectangles.

A *pyramid* (Fig. 91) has one base, its sides being triangles, with their vertices meeting in one point *a*, called the *apex* of the pyramid. (As it is advisable for the student to confine himself for the present to the study of the projection of *plane* solids, we defer any consideration of the *circular* ones until after the projection of *curved lines* in any position is understood by him.)

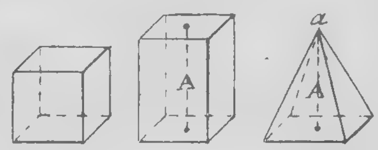


Fig 89 Fig 90 Fig 91


Fig 92 Fig 93

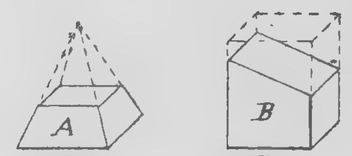


Fig 94 Fig 95

Regular prisms and pyramids have "regular" figures for their bases.

The *axis* of a prism, or pyramid, is an imaginary line joining the centres of the bases of the former, and the centre of the base and the apex of the latter, as the dotted lines A A in Figs. 90 and 91.

A *right* prism, or pyramid, has its axis perpendicular to its base, as Figs. 90 and 91. If its axis is inclined to its base, the prism or pyramid is *oblique*, as in Figs. 92 and 93.

A *truncated* pyramid or prism, is the part of the solid left when its *upper* part is cut away by a plane, and is called a *frustum*. The cutting plane may be either parallel or inclined to the base of a pyramid, but only inclined to the bases of a prism. In Figs. 94 and 95, A and B are frustums.

As all the sides of a prism are parallel to its axis, the edges of the sides connecting its bases are perpendicular to the bases in a "right" prism, and inclined to them in an "oblique" one.

In a right pyramid all its sides are isosceles triangles, and its axis is perpendicular to its base. If the base is a regular figure and the axis perpendicular to it, the sides of the pyramid will all be equal and similar isosceles triangles, but if the axis be inclined to the base, then the sides become unequal triangles and the pyramid an oblique one.

Both prisms and pyramids are named according to the figures of their bases. If the base is a triangle, square, pentagon, hexagon, or octagon, then the solid becomes a triangular square, pentagonal, hexagonal, or octagonal pyramid or prism, as the case may be.

There are other plane solids, such as the tetrahedron, octahedron, etc., etc., but such forms are seldom adopted by the engineer or machinist in his constructions. Their special features may, however, be studied to advantage by the student draughtsman in his spare time.

(*To be continued.*)

Basis of Duty Rating of Steam Motors.

CONSIDERING the rapid advance during the past few years in development of the efficiency of steam-actuated machinery, it appears somewhat singular that the methods of measuring the results obtained should not also have been the subject of a like degree of improvement, and that the antiquated, crude, and indefinite standards have not been universally discarded. Certainly any basis of comparison involving the consideration of extraneous conditions or quantities must involve more or less complication and uncertainty as to exact results, which necessarily detract from their value, and can be excusable only in default of sufficient knowledge of the subject to enable us to devise a more exact method. Modern scientific engineering surely is not a matter of guesswork. In all essential features it may be regarded as one of the exact sciences, for the reason that its fundamental theories are confirmed by actual practice, or at least by experimental demonstration by numerous authorities, whose several results agree so nearly as to warrant their universal acceptance as factors in our calculations.

The continued use, then, of the imperfect and misleading methods referred to—as it cannot be attributed to lack of knowledge for adopting a better—can only be accounted for on the ground of tradition. It is the rut out of which it is difficult to climb because it has been a universally-accepted practice in the past, and for that reason only it must be all right.

With reference to efficiency tests of a steam plant—that is, the entire system of generating, conveying, and utilising apparatus — there is probably no better method available than the one now in use, in which the basis is a comparison of the effective work realised from a given quantity of fuel consumed. But even here there is an unnecessary distinction made for different applications of the steam power. For an engine designed to furnish power by transmission for general purposes, the economy or efficiency rating is based on the consumption in pounds of fuel per horse-power per hour; or, by a more recent method (not generally used, however), on the consumption of steam in the denomination of pounds of water per horse-power per hour. But an engine, even though it may be of exactly the same type as the former, if used to actuate pumping machinery, is rated according to the resultant number of foot-pounds for a fuel consumption of 100lb. of coal. If the duty in the former case is satisfactorily expressed in terms of pounds of coal or water per horse-power per hour, there is no apparent reason for considering it less applicable to the duty of pumping, and thereby avoiding an unnecessary distinction involving a difference of basis and multiplication of methods. If, for the purpose of greater convenience or accuracy of results, the latter method is desirable, it is equally so in case of the power engine, to which it is quite as applicable. Where can be the necessity for, or advantage of, the distinction, when in either case the results represent only the comparative ultimate utilisation of an ascertained proportion of the known heat energy of the fuel, which is the only crucial test of efficiency?

It is true that an engine used for pumping, whether independent or combined with the pump as a unit of construction, is not considered simply as to its individual efficiency as a motor, but almost invariably as a pumping machine, in which the pump itself is an equally important factor. A power engine, on the contrary, is rated entirely with relation to the amount of power developed at the point of transmission—say the crankshaft. These facts, however, are very generally understood, even by the layman, and the expression of efficiency in the terms of either method would be self-apparent in either connection. Of course, while uniformity of terms is desirable for the sake of simplicity, it is by no means essential as to correctness of results or their mode of expression; and its absence, therefore, is not open to criticism, except on the score of convenience. But this is true only with reference to tests of efficiency of the entire steam plant, considered from the standpoint of cause, represented by the cost of fuel and attendance, and effect in the shape of useful work accomplished.

It is needless to say that such tests are exceptional, and that, as the individual efficiency of the component parts of the plant—*i.e.*, the generator and the motor—one or both—is made the subject of separate investigations, the application of any such method must be barren of accurate results so far as the motor is concerned, though, of course, correct with reference to the generator, provided careful and complete evaporation data be obtained.

Let us suppose, for instance, that it is desired to ascertain the efficiency of an engine furnishing power for transmission, and apply the usual mode of procedure, which is, briefly, to keep accurate records of fuel and water consumption and weight of refuse, as representing the cost; and the work performed by the engine, as ascertained from a series of indicator cards, taken at short intervals during the entire period covered by the test. The indicated power of the engine, whether in foot-pounds or horse-power, certainly represents the amount of work realised from a given quantity of fuel; but, just as certainly, it cannot show the net efficiency of the engine, on the basis of either fuel or water consumption. The reason is obvious. Fuel will be used in proportion to the evaporative efficiency of the boiler, and, therefore, can become a factor only as governed by the latter, which is not stated where the engine is rated on fuel consumption per horse-power per hour. Consequently, it means absolutely nothing.

Water consumption is a little nearer the mark, as it eliminates in part the question of boiler efficiency. Not entirely, however, as the consumption of feed-water does not by any means indicate true evaporation to steam at normal saturation. There are many causes which may exist in the boiler to affect the quantity of water carried into the steam pipe, and as its place must be supplied by the feed, it is therefore charged to the engine, notwithstanding the fact that the latter not only derives no gain from its presence, but actual loss to a very considerable extent. Or, suppose the evaporation by boiler to be all that could be desired, and the steam delivered to the header at a saturation to its pressure. There is inevitably more or less condensation in the pipe between the boiler and engine throttle, and this represents a corresponding loss of efficiency in the steam—usually not a trifling one. Nevertheless, as the boiler has delivered it, the weight of steam it represents is charged to the engine; though, again, it suffers from the presence of the contained water beyond the shrinkage in volume of the steam.

These are but two of the many conditions which may cause a grave discrepancy to exist between the apparent consumption of steam by the engine, as measured by the feed water, and the actual amount fairly chargeable to it as at normal temperature and saturation. As these facts are beyond question it logically follows that the results of efficiency tests on either fuel or water consumption basis are fallacious, and manifestly unfair to the engine. The plan is sometimes adopted of rating an engine by the indicated power developed in connection with certain assumed evaporation, fuel consumption, etc.; but as this is much in the nature of guesswork, it can hardly be accepted as a conclusive or satisfactory test.

The question is, then: What method can be employed which will not be open to one or all of these objections? Broadly answered, it should be on the basis of the quantity of heat actually delivered at the engine throttle, by steam at normal saturation, through a pipe of ample sectional area to prevent any loss of energy from friction or wire-drawing. All water, whether carried over in mechanical suspension from the boiler, or from condensation in the pipe, should be removed by some efficient form of separator located as nearly as possible to the throttle-valve, beyond which point all subsequent losses of heat and expansive energy are properly chargeable to the engine.

Of course it is not the intention, in this connection, to go into the details of such a method, but merely to consider the correctness and applicability of the heat basis suggested. If, then, the steam be delivered at the throttle freed from all abnormal conditions due to generating and transmitting, the indicator card should be a correct exhibit of its action in the cylinder under the rated load of the engine. The net amount of the latter may be determined by comparing the friction card of engine alone with that representing full load, and may be figured in foot-pounds. The net steam consumption, actually ascertained by deducting the weight of discharge from separator from that of feed water, may be considered by its contained heat in terms of thermal units, and the result of test stated by the number of foot-pounds per 100, 1000, or 1,000,000 heat units, which, being an exact quantity, represents accurate information.

This method has been used by some of the largest engineering concerns, notably the Henry R. Worthington Company, in testing the efficiency of their high duty pumping engines. There does not seem to be, however, any good reason, on the score of utility, for multiplying the figures by stating results in millions of foot-pounds per 1,000,000 heat units, as has been done, for the reason that a comparison of the two quantities may be as accurately made by using a single heat unit. Thus, in case of a duty of 109,850,000 foot-pounds per 1,000,000 thermal units, the statement would be 109·85 foot-pounds per thermal unit—certainly less cumbersome than the former. By this method, the percentage realised of the full theoretical possibilities may be instantly ascertained. We have only to divide the duty found by Joule's equivalent—772 foot-pounds per heat unit—thus, $\frac{109\cdot85}{772} = 14\cdot23$ per cent. Such a comparison might be even a better statement, and the expression of duty rating be in percentage of theoretical equivalent.—"Iron Age."

The Relations of Chemistry to Foundry Practice.—IV.

Copper.—Copper is one of the metals of antiquity. The art of tempering or hardening it has been lost, although recovered by the newspapers at stated intervals. Its usefulness in the arts has been the means of making its properties widely known. It is, perhaps, familiar knowledge that it is compounded into a great variety of alloys, such as brass, bronze, bell-metal, etc., all of which are hard and brittle when cooled slowly, but become soft upon being heated and then suddenly chilled. Copper is found as native or free copper, and as such, or combined with other elements, is abundant in nearly all countries. It has a deep red colour, and is ductile and malleable. For electrical purposes its usefulness is well known. Found in pig iron it may have been derived from any of the materials used in a blast furnace.

Calcium.—Calcium is a light yellowish coloured metal. There are several modes of producing it, among which the electric current is employed with success. It is very oxidisable and burns with a bright flame in the air, forming calcium monoxide or lime. Limestone is, therefore, the kind of rock having calcium as a base. Geologically, limestone occurs among the oldest rock formations, and occupies vast areas of the earth's crust. In the great valley of Pennsylvania, along the banks of the Lehigh River, it lies in all possible positions, and covers thousands of acres in an unbroken field. Calcium is also combined in a different state in chalk and gypsum, and is present as a mineral constituent in a majority of formations. Marble is a variety of limestone. When marble or common limestone is heated the carbonic acid with which the calcium is combined is driven off and a white infusible substance called caustic or quicklime remains. This is the calcium monoxide, which combines with water with generation of great heat, forming calcium hydryoxide, or slaked lime. Either slaked lime or lime dissolved in water has a strong affinity for carbonic acid, which it absorbs rapidly from the air, reproducing calcium carbonate. We utilise this property in mortars and cements, to which they owe the hardening or setting. As lime, calcium finds a hundredfold uses. In the blast furnace and cupola it is employed as the vehicle for carrying off undesirable impurities. Lime and silica alone are infusible compounds. United they fuse readily, combining to form various silicates of lime, etc., and in addition to this they open up to the action of the gases the finer particles that would otherwise be deleterious to the final products. Calcium carbonate crystallises in two distinct forms; the commoner form is named calcite.

Magnesium.—Magnesium is a metal distinguished in its occurrence by being closely related to calcium. Like calcium, it has but one oxide, called magnesia, the monoxide. It exists in the crystalline and massive state, as dolomite, analogous to calcite. From the nature of the oxides lime and magnesia, the metals calcium and magnesium may be said to replace each other interchangeably. There are few limestones which are non-crystalline that do not contain magnesia in small quantity. In the metallic state magnesium is silver white, oxidises but slowly, and fuses at a low red heat. It can be cast, is soft, very light and ductile, though usually it is pressed into wire. In the form of ribbon, magnesium can be ignited with a match, and burns with a dazzling light, which is white but very rich in chemically active rays. On this account it is employed as a substitute for sunlight in photography. The magnesium flash light is produced by the combustion of the metal finely powdered. The white substance found on these lamps is the resulting oxide—magnesia. Associated with lime it finds its way into the blast furnace, but is often specially used as dolomite alone to obtain certain results in fluxing. Both magnesium and calcium are common ingredients of iron ores, more particularly hematites, and although so easily oxidised and extremely hard to reduce, are considered by some authorities to become incorporated in pig irons.

We have now come to the more rarely occurring elements, nickel, chromium, tungsten, vanadium and uranium. Suffice it for our present purpose to state that they are all metals, as we have at this point learned to consider such, and although differing radically in chemical and physical aspects, they appear to give but one property to iron and steel in the quantities in which they have so far been introduced. We have to deal with them only as they may be present in cast iron, but since their occurrence in nature is in minerals nearly altogether associated with iron ores, we may have future occasion to refer the peculiar behaviour of a casting to the indication of one or more of these elements, and we are then prepared to know at least that these metals are accompanied by given effects.

From this view we have rapidly taken of the chemical elements with which this discussion treats, we are equipped to scan the horizon that now spreads out rather broadly before us, and recognise in approaching objects an intelligent significance of the signals they display, let us hope, in accordance with the codes laid down by the founder's tools and the machinist's lathe. We know pretty well about what objects to expect, and we will proceed in an endeavour to interpret not only the meaning of their appearance, but also to inquire what amounts of each, or all, fulfil the requirements of our search.

(*To be continued.*)

Shipbuilding Notes.

Messrs. Schichau, of Elbing, Germany, have obtained an order from the Roumanian Government for four small gunboats.

Messrs. Watts, Ward and Co., of Cardiff, have placed an order for three large steamers with Messrs. Ropner and Son, of Stockton-on-Tees.

The Grangemouth Dockyard Company have received an order to build a steamer of about 4000 tons carrying capacity for the General Cargo Line of Messrs. Macbeth and Gray, steamship owners, Glasgow.

Messrs. A. Rodger and Co., shipbuilders, Port-Glasgow, have contracted to build a 3000-ton cargo-carrying steamer for Messrs. Burrell and Sons, Glasgow. Messrs. Dunsmuir and Jackson, Glasgow, will supply the machinery.

The steam tug "Knight Templar," built by Messrs. Mackie and Thomson, Govan, went for her trial trip on the 13th inst. The vessel is 95ft. long by 20ft. 8in. by 11ft. 6in., and is driven by a set of triple-expansion engines, with cylinders 12, 20, and 34in. diameter by 24in. stroke, working at a pressure of 200lb. The usual speed trials were made on the mile at Skelmorlie, the speed attained being about $11\frac{1}{2}$ knots per hour.

There was launched on the 15th inst., from the shipbuilding yard of Messrs. W. Harkess and Son, Middlesbrough, a steel and iron screw steamer, built for Messrs. J. Burnett and Sons, London. The dimensions are as follows:—Length, 182ft. 1in.; breadth, moulded, 26ft. 6in.; depth, moulded, 12ft. 9in. The engines are by Messrs. Westgarth, English and Co., Middlesbrough, having three cylinders $15\frac{1}{2}$, 25, and 41in. diameter by 27in. stroke. She is fitted with a large boiler, which, together with the donkey boiler and all deck machinery, works at a pressure of 160lb. per square inch. The vessel will carry a cargo of about 630 tons on a mean draught of 11ft.

The steamer "Delaware," built by Messrs. David J. Dunlop and Co., engineers and shipbuilders, Port-Glasgow, to the order of the Anglo-American Oil Company Limited, of London, for carrying petroleum in bulk between the United States and Great Britain, successfully underwent her different trials on the 16th and 17th inst. The principal dimensions are:—Length between perpendiculars, 345ft.; breadth, moulded, 44ft.; and depth, moulded to spar deck, 31ft. 6in. The gross deadweight on board at the time of the trials was 5400 tons. The engines are triple expansion, and have cylinders of 27, $43\frac{1}{2}$, and 20in. diameter by 51in. stroke, with two large double-ended boilers, the working pressure being 160lb. per square inch. The highest mean speed attained on the progressive trials was fully $12\frac{1}{2}$ knots.

Hydraulic Lifts.

(*Continued from page 248.*)

Whilst considering the question of safety, the author would like to draw attention to the construction of entrance doors or gates, for, although not actually part of the lift, they are so nearly allied with it that their consideration should not be parted from it. There are endless patents and proposals bearing on this one point, and in the great majority the idea seems to be that the doors or gates should open automatically when the cage approaches the level of the floor, and close automatically when it passes away. This may be done with advantage at the top and bottom floors only, because when the cage is approaching either of these floors, the intention is to stop there, but with the intermediate doors it is different. The cage may be going past the first floor, when it is worse than useless to open and close the door as it passes. The intermediate doors should be opened by hand, and closed automatically when the cage passes away from the floor. Bolts can be so arranged that the doors can only be opened when the cage is level with the floor. Another good arrangement is to lock the starting rope when the door is opened; the lift cannot then be started until the door is closed. In this case, of course, the door does not close automatically, but has to be closed by hand before the cage can be moved.

The author would suggest that all passenger lifts should be examined, and a certificate given by a Government expert or inspector before they are allowed to be used for passenger traffic. Many lifts carry as many passengers during the day as a small line of railway in a country district, and, although the journey is short, if the lift is defective the danger may be great. The time occupied by the inspection would also be short, and tests might be made in the presence of the inspector, who should have power to withhold his certificate unless he considers the lift perfectly safe. This would ensure that passenger lifts, at least, should be well designed and constructed, up to a certain standard of excellence. The inspection of warehouse lifts, where persons are allowed to travel in them, would soon follow, and so the makers of these lifts would be compelled to turn out good work. Extreme cheapness should not be the first consideration for machines of this kind when absolute safety is of the utmost importance. True economy is not always the same thing as small outlay; a thoroughly good machine is generally cheapest in the long run, although it may cost more in the first instance.

In one form of suspended low-pressure lift the cylinder is stood vertically, and the water is introduced above and below the piston, by which means nearly an equal power is exerted throughout the entire stroke. The pressure due to the height of water above the piston, and the sucking action of the column of water beneath the piston combined, would be the same in any part of the stroke if it were not for the small area of the piston rod, and this slight loss of power, as the piston descends, is generally more than compensated for by the weight of the ropes suspending the cage passing over the top sheave from the cage to the opposite side; if it were necessary, by apportioning the size of the rod and the weight of the ropes, an exactly equal power could be obtained throughout the whole travel of the lift. This is a very good arrangement, and was introduced into use in this country some years since by the American Elevator Company; but, strange to say, this exact form was patented in this country by Harriott and Strode in 1802. The specification is not now in print, but it can be seen at the Patent Office Library. It is most carefully and accurately drawn, and describes this method of using a vertical cylinder. The author merely mentions this as showing how curiously before its time this invention was.

An ingenious arrangement is sometimes used for balancing the weight of the ram and cage of a direct-acting lift, and at the same time equalising the power throughout the travel of the lift and thus reducing the quantity of pressure water used. The displacement ram is weighted to nearly counterbalance the weight of the lift ram and cage as in the Elington balance, but the actuating ram acts on the displacement ram through chains or ropes which coil on to cam-shaped barrels or fusees so that the downward pull on the displacement ram increases as it descends, thus increasing the pressure as the lift ram ascends, obviating any loss of power by protrusion. The balance was patented by Mr. Archer, and is manufactured by Messrs. Richardson and Co. Limited; it is an example showing the endeavour lift manufacturers are making to reduce to a minimum the quantity of water used by their lifts.

The author will next direct attention to a new system of hydraulic lifts and cranes, by which the quantity of water used is automatically approximated to the load raised. He is quite aware that multiple-power machines have been made for a great number of years; that is, multiplying cylinders or jiggers, and also direct-acting lifts with more than one ram, a light load being raised by admitting water to one ram, a heavier load being raised by admitting it to two, and so on. In some instances a ram and piston are used. When the pressure water is admitted to both sides of the piston, the annular space round the ram is in equilibrium, and the area of the ram only is effective. When the pressure water is admitted to the back of the piston, and the water from the annular space round the ram is open to exhaust, the whole area of the piston is used and the maximum load may be lifted. In other arrangements there are two rams, the smaller one working inside the larger, the bottom of the large ram being open. When a light load is to be raised, the large ram is held back by powerful claws or clips attached to the cylinder; when heavy loads are to be raised the large ram is released and the two move as one. In this arrangement the combined areas of the two rams are not used, but the area of the large ram has to be sufficient of itself to raise the maximum load. All these methods, however, are more or less clumsy, and must take time to alter from one power to another. Therefore, on account of the time and trouble involved, the alteration is only made when a great number of light or heavy loads have to be raised in succession. The arrangement that looks most promising at first sight is that in which the power is increased by simply pulling the hand rope farther on, the water being admitted to two rams, or the exhaust made from before the piston as before described. But there are difficulties in this; for instance, if a heavy load has been raised and the lift stopped, the rope only having been moved to the point at which it will stop when the heavy load is in the cage, when the load or part of the load is taken out, the lift starts on again until the rope is moved still farther. This, of course, is a serious fault. It may, perhaps, be provided against, but the fact of leaving the attendant the option whether he will go on to the first or second power is not satisfactory, as, in order to save trouble, he will generally elect to go on to the second or largest power, although the machine was intended to save water, and not trouble. Again, with this arrangement there cannot well be more than two powers, whereas to be a really economical machine there should at least be three powers or grades, if not four or even more, and the discretion as to which grade should be used should not be left to the person working the lift or crane, but should be automatically selected.

(*To be continued.*)

Notices of New Books.

Portative Electricity: Being a Treatise on the Application, Methods of Construction, and the Management of Portable Secondary Batteries. By J. T. Niblett. London: Biggs and Co. 2s. 6d.

Whilst to the ordinary reader the title of this treatise may seem a trifle too technical, yet the greater portion of the work is of a popular nature, and appeals to a wider section of the community than might be inferred from the statement that it is mainly intended for the guidance of those who are in possession of small secondary batteries, or who may find this form of stored energy of service by reason of its adaptability to artistic or scientific purposes. The work is divided into three parts, treating respectively of some uses of portative stored electricity, secondary cells, and the management of portable apparatus for storing electrical energy. Commencing with portable electricity in mining operations in so far as miners' lamps and instruments for detecting firedamp are concerned, the first part passes on to consider lamps for domestic purposes and for the use of custom-house officers and inspectors of gas meters; search lights, signalling from balloons, electric launches, electrically-lighted railway carriages, and portable lamps for travellers; and tramcars and omnibuses lighted and propelled by electricity. The pages dealing with electricity for decorative purposes, and which are illustrated so as to very effectively impress the reader, will prove very attractive. Apart from the text referring to and illustrations of lamps for table decorations, show windows, electrically-lighted fountains and jewellery, those concerning stage effects will interest almost everybody. The most striking of the latter is "La Danse Electrique" performed recently at the Alhambra Theatre. In this case the display was effected by a lady practically framed within a bouquet of flowers, in which were intermingled many glow lamps. These were connected by flexible wires to contact plates fixed on the soles of the performer's shoes. On the stage, and let into it, were a number of copper contact strips which formed the terminals of a source of electricity. Whenever the performer stepped upon two contact plates of dissimilar polarity, the lamps were immediately energised, producing a brilliant and intermittent illumination, and a beautiful spectacle. The second part describes some secondary batteries, and the third gives charging instructions for accumulators which are of great value to users. The book is written in a popular style, and will not only be of value to those using, or intending to use, portative electricity, but also to general readers who desire to learn something of the applications of electricity without being bothered with technicalities.

A Pocket-book of Electrical Rules and Tables for the Use of Electricians and Electrical Engineers. By John Munro and Andrew Jamieson. 9th Edition. London: Charles Griffin and Co. Limited.

When electrical engineering was undergoing rapid development, some ten years ago, Messrs. Munro and Jamieson's pocket-book first made its appearance; and although since that time many other works of a similar character have been published, it is not too much to say that the pocket-book under notice still retains the premier position. That this is so, is due in a very great measure to the repeated revision of the work as each new edition is called for, as well as the addition of the new matter necessary to keep the work well up to date. In the present issue several important matters are incorporated. These include a new capacity test of Lord Kelvin's multicellular voltmeter, Muirhead's method of correcting Thomson's capacity test for absorption and leakage, Board of Trade instructions for making the Clark cell, testing of transformers, etc.

Although information is to be found in the pages of this pocket-book on almost every conceivable matter pertaining to electrical engineering, nothing is said as to motive power for dynamo driving. We think that a few concise notes on gas and oil engines, as well as on steam engines, boilers, etc., would be of advantage, and render the work complete in every sense. We must not omit to mention that a very copious index is provided—an invaluable feature in a work of this class. The book, which is well printed and strongly bound, should certainly be in the hands of every electrician and electrical engineer, for it is the best and most complete pocket companion we know of.

The Management of Accumulators. By Sir David Salomons, Bart. London: Whittaker and Co.; and George Bell and Sons.

This work can scarcely be called the seventh edition of the author's "Electric Light Installations and Management of Accumulators," since it has for the most part been rewritten, thus forming practically a new work. There is a useful introductory section, giving in a general way an account of electric lighting, after which there is given a description of the principal forms of accumulators and the mode of employment, a large number of illustrations being included in this division of the work. The following chapter is on setting up the cells and the accumulator house, much practical advice and many useful hints being given; a description of the Broomhill accumulator house is also included. Chapters 3 and 4 deal with charging and discharging the cells; Chapter 5 is on failures—their cause and remedy; and Chapter 6 on testing a section. The subject has been treated in a plain, straightforward style, and we can unhesitatingly recommend this little work as a capital practical handbook on the subject.

Metal-plate Work: Its Patterns and their Geometry. By C. T. Millis. London: E. and F. N. Spon.

Since the first edition of this work appeared in 1887 we have had many opportunities of recommending it to correspondents seeking for a book on the constructive details of metal-plate work. We are pleased to find that a second edition has long been called for, and as about 70 pages of new matter have now been added, the work should prove still more useful to the sheet-metal worker who desires to fully master his trade. We consider it a specially good feature of Mr. Millis's book that no previous knowledge of geometry on the part of the reader is necessary. We can most cordially recommend this work to the notice of tin, iron, and zinc-plate workers, coppersmiths, boiler makers, plumbers, etc.

The Locomotive Engine and its Development. By Clement E. Stretton. London: Crosby Lockwood and Son. 3s. 6d.

Although only a few months have elapsed since we noticed the first edition of this readable little work, a second edition has already appeared. This gives opportunity for the insertion of several additional illustrations and particulars of the old engines which form links in the history of the locomotive. Those interested in locomotive history will find the work very acceptable, as it contains a deal of information not to be found in any other volume.

Trade Notes.

The tender of Messrs. Reid Brothers, of London, has been accepted for the electric-lighting works at Woolwich.

Messrs. D. Y. Stewart and Co., Glasgow, have secured the Bathgate, Linlithgow, contract for 2670 tons of cast-iron pipes.

Messrs. Crouch and Hogg, of Glasgow, have submitted estimates for two steel bridges to the Mid-Ross District Committee.

The Victoria Foundry Company have acquired the Herrick Street Iron Foundry, Wolverhampton, which has been idle for several months.

Messrs. Grenfell and Accles, Holford Engineering Works, Birmingham, are supplying the machinery for the Automatic Chain Company.

Messrs. Head, Wrightson and Co., of South Stockton, have obtained an order for a quantity of bridge work for the Chinese Imperial State Railways.

Messrs. Clark, Muirhead and Co., of London, have obtained the contract for the electric-lighting plant for the installation at Ealing.

Messrs. Dick, Kerr and Co. Limited, of London, have secured the contract for the reconstruction of the Greenock Corporation tramway.

Messrs. Burgdorf Brothers, of Altona, Germany, have recently constructed an electrical crane for the North German Refinery, at Hamburg.

The Southampton Naval Works, formerly in the occupation of Oswald Mordaunt and Co., will be offered for sale at the Mart, London, on July 21.

Messrs. R. and J. Dempster, of Newton Heath, Manchester, have obtained the contract for the erection of four gas purifiers at Sutton-in-Ashfield.

Messrs. Barr and Co., of Greenock, have just completed a large copper vacuum pan, being part of a contract for sugar-refining plant for China.

The directors of the Manchester Ship Canal Company have placed an order for four large steel sheds with Mr. Edward Wood, Ocean Ironworks, Manchester.

Messrs. Blair and Co., of Stockton, have contracted to supply three sets of triple-expansion engines for three steamers to be built by Messrs. Ropner and Son, of that town.

The directors of Messrs. George Fowler, Son and Co. Limited announce a dividend of 7 per cent. on the preference shares and 10 per cent. on the ordinary shares, for the year ending April 29.

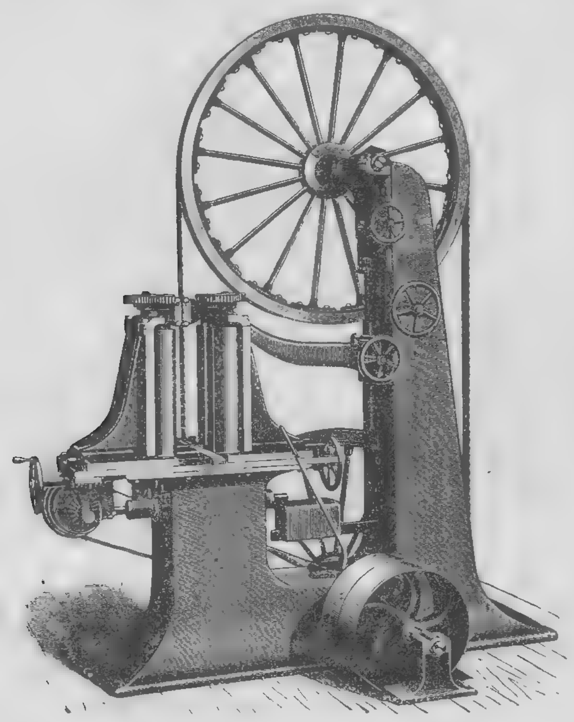
The tender of Messrs. Hawkins and Best, of Teignmouth, has been accepted by the Budleigh Salterton Local Board, for the construction of a pumping station and machinery, and also for 2000 yards of cast-iron pipes.

The Lodge and Davis Machine Tool Company, of Cincinnati, have received a large order from the West Coast of Africa for a number of lathes, planing and drilling machines, for use in the manufacture and repair of sugar machinery.

The Chicago Exhibition.—V.

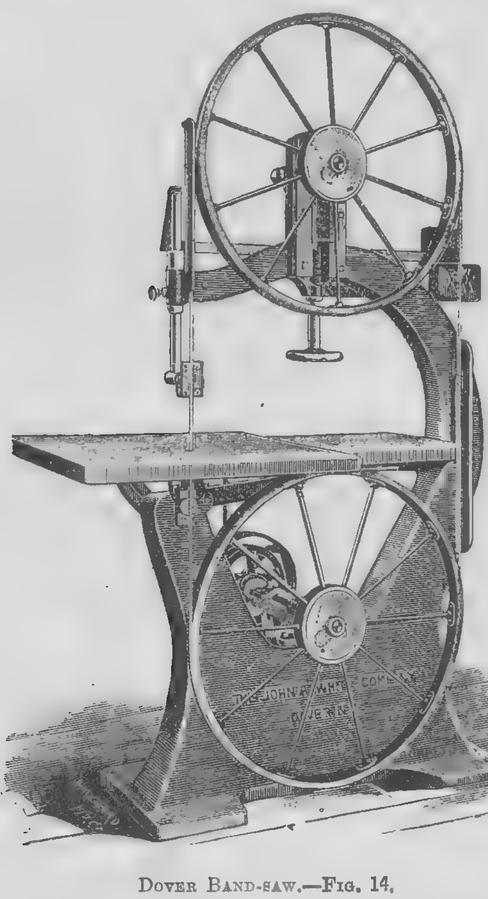
By Our Special Representative.

Passing on to another exhibit of wood-working machinery, we come to that of the John A. White Company, of Dover, N.H., who exhibit machines for nearly every conceivable purpose in wood working. Fig. 13 represents their 54in. band resawing machine, capable of working hard or soft wood up to 24in. wide. The frame is very substantial in appearance, and is designed to afford easy access for inspection and lubrication. The wheels are 54in. in diameter, all iron and steel except the rims, which are of selected dried stock, and will carry any saw up to 4in. in width. The spokes are of steel, thus combining lightness with strength; and their method of attachment to the hub provides a double bearing at the centre of the wheel. The feed rolls are six in number, all geared, and may be adjusted so as to be self-centring, or the right-hand rolls may be fixed so as to split stock to any desired thickness. The left-hand rolls are provided with springs, so as to allow for inequalities in the stock, while the feed mechanism may be instantly started or stopped by means of a hand lever placed conveniently in front of the operator. The feed gear is a patented feature of the machine, and comprises a specially designed form of differential gear. Stock may be fed at either 15 or 20ft. per minute as desired. The saw guides are of a revolving-disc pattern, of which a full description will be given later on, the upper one being adjusted to any desired height and counterbalanced. All adjustments are made while the machine is running, the saw tension being automatically maintained by a weighted lever. The capacity of the machine is for stock 24in. wide, and it will saw to the centre of 10in. thick. Stock as short as 6in. may be easily handled, owing to the arrangement of the feed rolls. The countershaft speed is about 700 revolutions per minute, the tight and loose pulleys being 24in. diameter. It stands 9ft. high and weighs about 1 ton 4cwt.

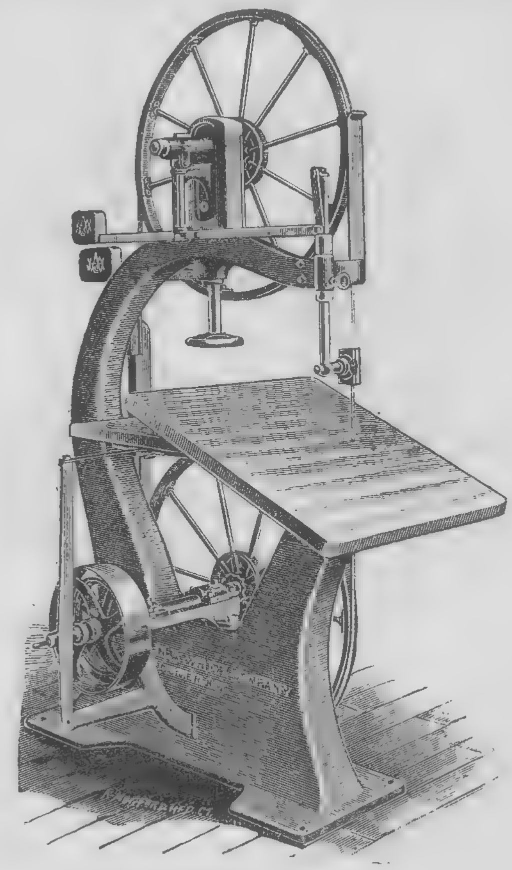


Band Resawing Machine.—Fig. 13.

The Dover band-saw, represented in Figs. 14 and 15, is the form finally adopted by the makers after a series of trials of different designs for a band-saw. The frame is cast in one piece and cored out, rendering it very light and at the same time leaving plenty of rigidity for its purpose. The table is made either in iron or wood, and can be tilted to any angle up to 30° A clamping device maintains the saw slot in line, regardless of the position of the table. The wheels are 36in. in diameter, and rubber-covered. The hubs are made with two concentric flanges, bored radially to receive the steel spokes, which, after passing through the outer flanges, are lapped into the inner one, giving two bearing points instead of one, as in ordinary wheels. The upper box is adjustable in every direction, so as to obtain the proper lead for the saw blade, and the hand wheels are so arranged as to allow of convenient access while the saw is in motion. The guide rod is carefully balanced by a weighted lever, and susceptible of easy adjustment for any thickness of stock, while by its method of connection it is prevented from turning, so as to change the alignment of the saw guide. The driving pulley is one of the most important features, as it serves also as a friction clutch, thus doing away with the ordinary tight and loose pulleys. The machine is stopped and started by a handle placed under the front edge of the table, which may be operated by the pressure of a finger. All the shafting throughout is of steel, and is interchangeable. It is recommended to run the machine at 400 revolutions per minute. A ½in. French saw is employed, cutting stock up to 12in. thick. The whole machine weighs about 1000lb.

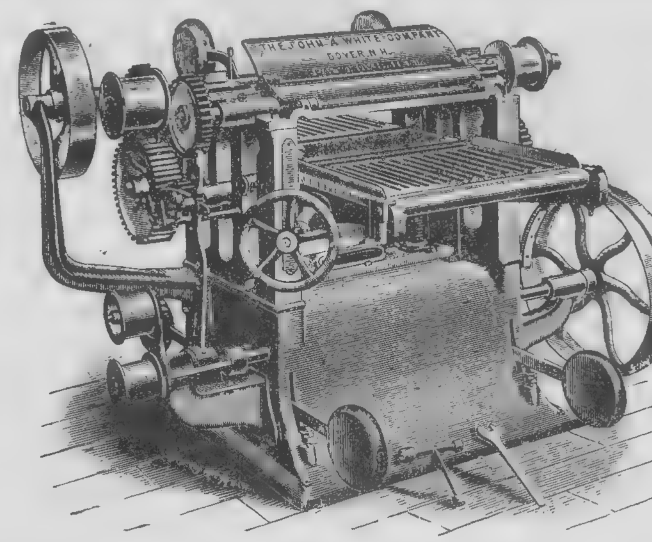


Dover Band-saw.—Fig. 14.



Dover Band Saw.—Fig. 15.

Figs. 16 and 17 represent a "Concord" planer by the same firm. The frame is made with the base cast whole, the side pieces carrying the cylinder, and roll bearings being securely bolted to it. The bed is raised and lowered by means of a hand wheel in front of the machine, operating by a train of gears upon two steel screws 1½in. in diameter, with gun-metal nuts 3in. long, forming at the same time a powerful and yet simple arrangement. One revolution of the hand wheel changes the elevation of the bed 1/16in. The feed rolls are so arranged that each is positively driven, but without the number of gears usually employed for the purpose, thus effecting a considerable saving in power. The cylinder is double-belted, and formed from a single piece of forged steel, with faces accurately planed, and turned to 1⅞in. at the journals. The knives are held in place by ¾in. Norway iron bolts, the cutting edges describing a circle 5in. in diameter. The cylinder bearings are 9in. long, and lined with babbitt, accurately fitted and tested under actual working conditions. The chip breaker is so arranged that it cannot come in contact with the knives, nor can it become wedged in taking the heaviest cut. The pressure bar is weighted, and thus made to yield slightly to the irregularities of the stock. This machine can be furnished with notching and beading attachments. It feeds at from 30 to 40ft. per minute, as desired. The speed of the countershafting is 950 revolutions per minute, the tight and loose pulleys being 12in. diameter. The largest size of machine weighs 3000lb., this size having a 30in. cutter.

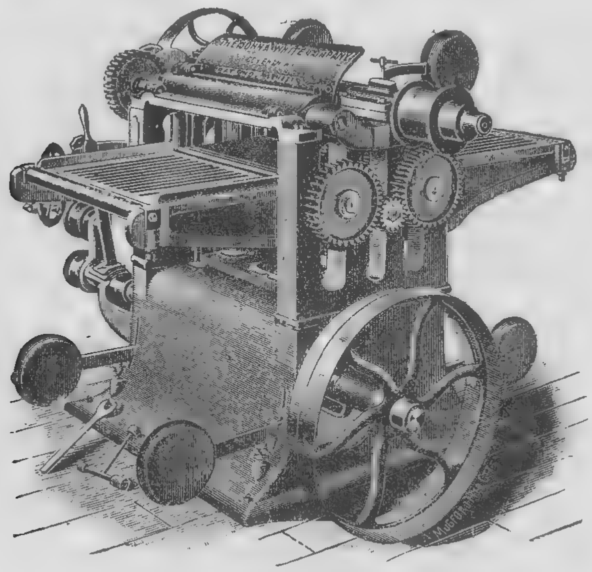


"Concord" Planer.—Fig. 16.

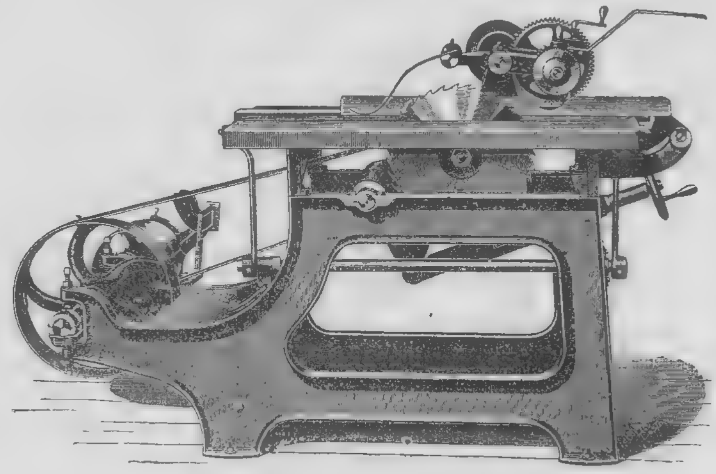
The mortising machine, as shown in Fig. 18, is specially designed for heavy car and bridge work. The frame consists of a hollow column cast in one piece, with broad base. The bed has a vertical adjustment of 12in., with a lateral motion of 9in., and is supported on a centre screw passing through the base, ensuring a solid foundation for the blow of the chisel. It will receive timber 17in. square between clamps, and by an ingenious device peculiar to this machine there is no blow on the treadle when the bottom of the mortise is reached. The chisel bar has a graduated stroke under perfect control of the operator, and is designed to carry tools up to 2½in. in width, having a maximum stroke of 6in. The boring attachments are two in number, one on the line of the chisel, the other adjustable to any distance. Both boring attachments are driven by a friction device operated by a lever on the side of the machine, and run by one belt only. The tight and loose pulleys are 14in. in diameter, and run at

250 revolutions per minute. The weight of the machine is 3000lb.

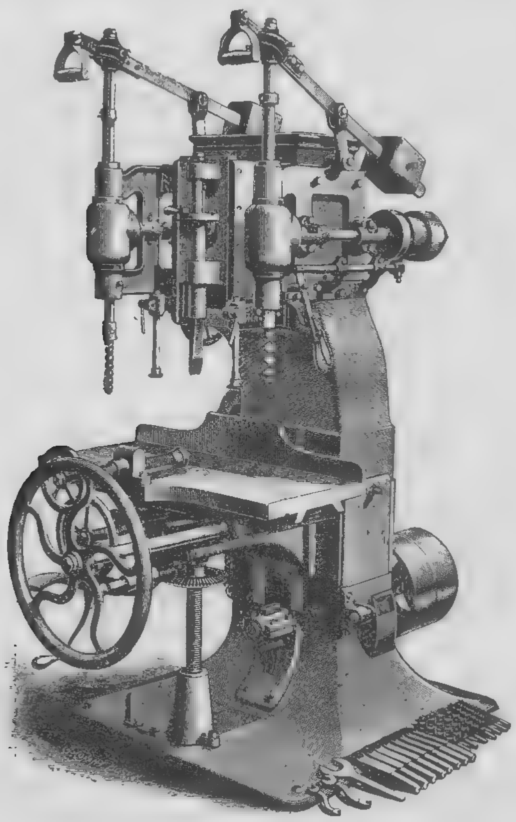
The self-feeding rip saw shown in Fig. 19 is constructed entirely of iron and steel, and will carry any saw up to 18in. in diameter. The spur feed wheel is placed directly in line with the saw, and is adjustable for any thickness of stock from ½ to 5in. It has three speeds—120, 96, and 72ft. per minute. The table is 42 by 36in., and is so designed that the left-hand portion will draw away from the saw, leaving ample space for changing saws or putting on dado or grooving heads. The arbor is 1½in. diameter at the saw, and runs in long babbitt-lined boxes carried on a heavy swinging frame, the position of which is regulated by a hand wheel on the front of the machine. The parallel guide is of a special patented design, and supported at each end of the table, ensuring true parallelism. It will give a maximum clearance to the right of the saw of 15in. The speed of the countershafting is 650 revolutions per minute, and the weight of the machine is 1200lb.



"Concord" Planer.—Fig. 17.



Self-feeding Rip Saw.—Fig. 19.



Mortising Machine.—Fig. 18.

(*To be continued.*)

The oldest industry in Great Britain is still being carried on at the village of Brandon, on the borders of Norfolk and Suffolk, and is reported to be in a flourishing condition. It is a manufactory of gun and tinder-box flints. It appears that there is no regular flint factory, but the work is done in little sheds, often at the back of the townsfolks' cottages. There is a good trade in tinder-box flints with Spain and Italy, where the tinder-box still keeps its ground in very rural districts. Travellers in uncivilised regions, moreover, find flint and steel more trustworthy than matches, which are useless after they have absorbed moisture. Gun flints, on the other hand, go mostly to the wild parts of Africa.

Evaporation by Multiple Effect.*

The author remarks that, from a purely engineering standpoint, one cannot help being surprised by the close analogy between the evolution of the evaporating apparatus and that of the steam engine. As in the steam engine there appeared first the old atmospheric engine, then the Watt condensing, and, lastly, the modern high-class condensing engine using the steam expansively, so in evaporation first came the old open kettle, then the vacuum pan, and, lastly, the multiple-effect evaporating apparatus, which also uses steam expansively and employs condensation. Indeed, it may be questioned whether the practice of using steam expansively in a steam engine, or the application of this same expansion of steam in evaporators, is of the greater importance to the preservation of the stock of fuel. As instances of the many industrial processes dependent upon evaporation and using large quantities of fuel, the manufacture of sugar, of salt, of ice from distilled water, of soda, glue, meat extracts, milk, and colours, are mentioned. The total weight of sugar produced in the season 1888-89 was, in round numbers, 2,665,000 tons of beet sugar, and 2,371,000 tons of cane sugar. The first evaporation of the juice, and also the subsequent refining—which operations have hitherto and are still very frequently effected in ordinary vacuum pans,—occasion a large consumption of fuel; but by the use of improved multiple-effect evaporators in beet factories the fuel does not much exceed 1·1lb. of coal per lb. of sugar, and the entire evaporation of cane sugar is performed with the refuse of the cane as fuel. The apparatus there referred to was originated and first patented by Mr. Rillieux, of New Orleans, many years ago. It was first made in Europe by Robert, in Seelowitz (Austria), and spread rapidly over the sugar districts in Europe. It has also been adopted in the West Indies.

A considerable proportion of the salt made in the United States is still produced in open pans. These consume about 1lb. of coal for 2·4lb. of salt produced, which is equivalent to about 7·9lb. of water evaporated per lb. of coal, while a triple-effect evaporator at the same establishment required only 1lb. of coal for 5·4lb. of salt.

Again, ice manufacturers and others requiring pure distilled water evaporate from 8 to 10lb. of water per lb. of coal; but by using multiple-effect evaporators 40lb. of sea water are evaporated by 1lb. of coal, and it is believed to be possible to evaporate 50lb.

These results are due to the utilisation both of the latent heat of steam and of the heat contained in the evaporated vapours during the process of evaporation; and the multiple-effect apparatus consists of a number of vessels—practically two, three, or four, sometimes five or six—connected with each other in such a manner that the vapour generated in the first vessel is taken to the heating surface or chamber of the second, the vapours of the second vessel to the heating chamber of the third, and so on. The vapour generated in the last vessel is liquefied in the condenser, which is a very important part of the apparatus, and should be cooled by the injection of a spray of water, with as high a vacuum as possible. The first of the vessels receives the heating steam from the boiler direct, or sometimes it may be supplied from a receiver in which the exhaust steam from all the different engines, pumps, etc., in the factory is collected.

Multiple-effect evaporation involves a larger amount of heating surface than is necessary when single pans are used, which implies also increased first cost of the apparatus, and for this reason single-effect evaporation is still employed where even a double-effect would very soon pay for the difference in the first outlay.

The apparatus used in sugar factories is described in much detail, and illustrated by a variety of drawings.

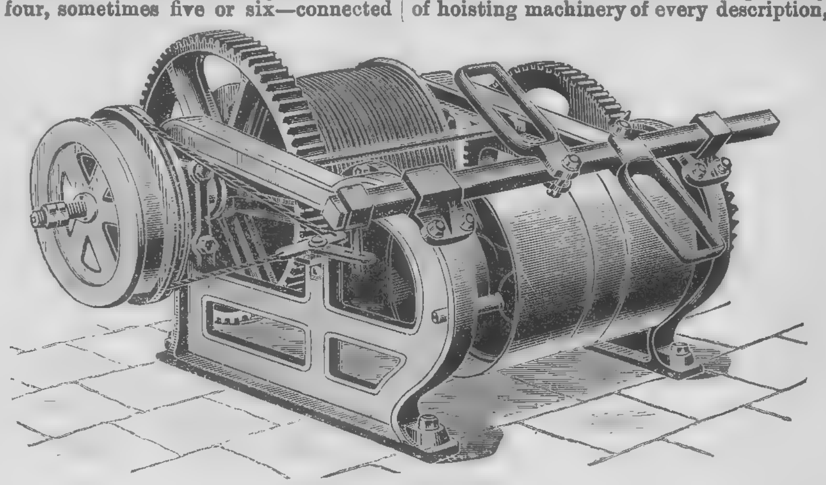
*Inst. C.E.: Foreign Abstracts.

The Hamburg Tramway Company are introducing electric traction on three of their lines.

Power Hoist Gearing.

We illustrate herewith a power hoisting machine for raising cages, as manufactured by Messrs. Pickering, Swain and Co. Limited, 5, John Dalton-street, Manchester. These machines can be fixed either on the floor or to the ceiling, and are driven direct or from a countershaft. A great defect of the old-fashioned worm-gear machines is that they are too slow in action; but this objection is entirely removed by the machine herewith illustrated. An important feature of the machine is that it requires less than half the usual power to drive it. It can also be controlled from either inside or outside the cage, which renders the machine adaptable to almost every situation. It is also fitted with fast and loose pulleys, spur and pinion wheels and improved throwing-on and off apparatus, and with automatic stop-motion, which prevents the cage from overwinding. The machines are made to suit any size of lift, and can be worked either with or without balance weights. It is claimed that they are perfectly safe and easily operated.

We may mention that Messrs. Pickering, Swain and Co. Limited make a speciality of hoisting machinery of every description, in connection with which they are constantly introducing new features. Their manufactures include hoists, lifts, cranes, etc., worked by hand, hydraulic, engine, and electric power. Additional particulars of the hoisting machine and of their other specialities can be obtained on application at the above address.



Power Hoist Gearing.

On Machine Designing.

[CONTRIBUTED.]

(*Continued from page 235.*)

THE CONDITIONS OF CHEAPNESS.

The principal conditions that conduce to cheapness in machinery may be very briefly expressed as follows:—

1. Simplicity of the design as a whole.
2. A complete set of working drawings, fully and clearly dimensioned.
3. Details of such forms as can be readily moulded, forged, or machined.
4. Parts such as wheels, levers, rods, and pins, standard and interchangeable wherever practicable.
5. Machined and finished parts of as small area as possible compatible with due efficiency and neatness.
6. Materials not needlessly expensive.
7. A good shop system for manufacturing, including special tools, and an

ample supply of gauges, copy plates, templates, and special fixings.

Castings are cheaper of ribbed than of cored sections, if only a few of them are required from the same pattern, because the expense of core boxes is saved. But cored sections are preferable for standard designs, for, besides their better appearance, the patterns are much more durable, since they can be constructed of any required degree of solidity. They are, therefore, less liable to warp, and better able to stand the rough process of "rapping" to which all patterns are subjected in withdrawing them from the sand of the foundry.

It is sometimes a matter of uncertainty whether to make a particular detail a casting or a forging. If only one or two such details are required, it is often cheaper to make a forging than to incur the expense of a pattern; but if a large number be required, castings are generally cheaper, the expense of the pattern bearing but a small proportion to the total cost.

THE METHOD OF DESIGNING.

Every machine is designed to accomplish some definite purpose, to perform a certain duty. To realise what this duty is demands the designer's first attention.

An analysis of the functions of machinery reveals the fact that there are general or primary, as well as particular or subordinate, functions. Thus the *general* function of a set of marine engines is to propel a certain ship at a given speed; but each detail, from the main cylinders down to the smallest screw, also has a *subordinate* function. And just as each letter of a word, each word of a sentence, and each sentence of a book has its use, so also each element or feature of a detail, each detail of a mechanism, and each mechanism of the whole machine, possesses its own definite function.

Or, again, just as in the human body each bone, muscle, nerve, and sinew has its special use or office; every *group* of bones, muscles, etc., its particular function (the hands, for example, to hold, the feet to walk with, the eyes to see, and ears to hear); and, finally, the *whole* man a duty in the world;—so, in like manner, in a clock, for example, each element has its own peculiar office; each spring, wheel, shaft, or finger something definite to do; each and every combination of these a specific purpose (to propel, to regulate, to transmit, or to indicate); and, finally, the whole clock a duty—to tell the time to eye and ear. The analogy holds good with respect to all machinery.

The secret is to get something down, however vague and sketchy; for one's ideas seem to grow and assume definite shapes in proportion as the pencil is kept going.

The first thing to be done, then, before attempting to design a machine or machine part, is clearly and fully to recognise its ultimate object—to know what it has to do.

This much being premised, the next step is to consider by what means or arrangement of mechanism this duty may be most effectually performed; then, pencil in hand, to scheme out a way of doing the thing. In this process rough freehand sketches, having no pretensions to accuracy or proportion, greatly aid the memory and imagination, and fix one's ideas.

In this initial stage of scheming out or originating, all the purely theoretical knowledge in the world will be of little direct use, although at a later stage it may prove very useful. Neither is skill in the use of instruments—mere manual dexterity—here of much avail. The operation is purely a mental one, demanding all the resources of the memory and of the reasoning and imaginative faculties. This is the time when the designer appreciates at its full value his familiarity with mechanical combinations, due to years of close contact and observation. This knowledge gives him such confidence in suggesting arrangements which he knows, by experience, to be practicable.

The method of the designer is in some degree analogous to that pursued by the mathematician in solving a difficult problem. He brings to bear upon the question all his knowledge derived from observation, training, and the experience that results from the solution of previous problems; but machine designing is a synthetical rather than an analytical operation. It is largely a tentative process of trial and error; of suggestion, examination, rejection, and revision, until finally a satisfactory solution of the problem has been arrived at.

Afterwards we may examine, modify, or possibly reject altogether. It is easier to revise than to originate. Of course, it would be unreasonable to expect always to hit off exactly the right thing at once. In fact, all good designs are the result of a process of evolution, and usually the result of the joint counsels of several minds towards its improvement. By thus trying we learn, at least, what methods will *not* do, and why; so that every attempt brings us nearer to the desired end. Thus we proceed, until at length we arrive at a result with which we are unable to find any fault, or, at all events, the method which seems to be the best compromise of all the requirements of the case.

Several methods will doubtless be suggested as being likely to satisfy the requirements of the case; but, upon close examination, it will generally appear that some one of these possesses qualities which make it preferable to all others. Or, possibly, a new solution may be devised, embodying all the excellencies of the preceding. It sometimes happens, too, when any mere modification of an existing arrangement fails to satisfy the conditions of the case, that an entirely new departure exactly fulfils all the requirements.

This first crude sketch contains the idea or principle—the germ of the complete machine. To settle this is often the most difficult part of designing, requiring great experience and a certain aptitude. When the principle has once been clearly evolved and stated, it becomes in general—though not always—a comparatively straightforward operation (albeit a lengthy one) to work it out or mechanicalise it; that is, to embody the idea in well-proportioned machine details.

This first approximation, which does not consider the proper size of the parts, but simply states, in the roughest manner, the principle and the relation of the chief parts, may be termed (in chemical phraseology) the *qualitative* design.

Afterwards, when each detail has been properly proportioned to the duty demanded of it, and the first crude conception reduced to order and just proportion, we obtain what may be termed the *quantitative* design.

The indiarubber forms an important factor in the work of designing. He who is afraid to rub out or reject his work, and to begin anew, is not the man to produce the best design; for all successful designs are the result of much thought and labour. A designer should himself be the most merciless critic of his own work, ever ready to condemn, and to begin again whenever a better way presents itself; for it is only by constant, untiring revision and perseverance that a high degree of excellence is attainable. A designer needs to have boldness, courage; a mind that will not slavishly adhere to precedent, that will not be satisfied a thing is right merely because it has been done this or that way before; he aims at originality, and is ever seeking to modify and improve. It sometimes needs courage to do this (as before observed), because any considerable modification in the position of an important detail in a design which is far advanced often entails an entire rearrangement and immense labour. Hence the first approximation should not be very carefully executed as to proportion and fulness of detail, for it is almost certain to require considerable revision before its final adoption.

It may here, in passing, be remarked that the judicious use of coloured pencils adds greatly to the clearness and intelligibility of complex arrangements, and may often be employed to much advantage.

If the machine be intricate, and the action difficult to follow, it is best, before proceeding to the elaboration of the design, to make a series of simple diagrammatic sketches, illustrating the different stages in the action of the proposed contrivance, adding brief explanatory remarks. This is done in order that no essential condition of operation may escape consideration, and therefore to diminish the probability of serious error. The diagrams should be numbered in due order, and arrows put on to indicate the direction of motion of shafts, wheels, levers, belts, and other moving parts; also the flow of currents of steam, air, water, or electricity.

If dealing with fluids, pressure should be indicated by *red* pencil lines, exhaust by *blue* lines. Such pictorial descriptions are much better than long and tedious written expositions, though some writing is necessary. When making them, a comprehensive view of the action of the proposed mechanism and its relation to other parts must be taken, and the cycle of operations carefully traced. The effect of making these sketches is to collect one's ideas and to classify the whole. By means of them, errors may often be early discovered and rectified which might otherwise have escaped observation until a much later stage. Thus much waste of time and consequent annoyance may be avoided.

When a gear has to be fitted into an existing arrangement, a piece of tracing paper is laid in position over the drawing and the proposed gear roughly indicated, modifications being made until a satisfactory arrangement has been arrived at. It is convenient always to have a few pieces of scrap tracing paper to hand for this purpose. Care is, of course, to be taken to see that such moving details as levers, cranks, and connecting rods, do not, at any period of their travel, "foul" existing parts.

(To be continued.)

The Modern Travelling Crane.

(Continued from page 245.)

LET us now, by the aid of the lantern, visit the new erecting shop of the Baldwin Locomotive Works, and see how this business is accomplished to-day. As we enter the shop we are impressed with its extensive floor space, its unusual height, its light roof, composed largely of glass, and its immense windows, which admit a great flood of light. Upon the floor we see scores of locomotives in every stage of manufacture. We perceive that the entire floor space is occupied by the work in hand, and we look in vain for the huge masts and arms, and, if we have not kept in close touch with recent progress in such matters, we may well wonder how these heavy materials are conveniently and expeditiously handled.

Presently we see an immense hook descend from above, grasp a cylinder or a boiler, or possibly a completed locomotive of the largest size, and sail away with it as readily as though it were a toy. We turn inquiringly to our guide and ask, "What do you call this great mechanical power?"

The answer is contained in the title to my paper for the evening. It is the modern travelling crane.

The old-fashioned, cumbersome jib-crane, slow of motion and limited in scope to the swing of its clumsy arm, so long a prominent eyesore on the floor of every foundry and machine shop, is gradually disappearing, and is being superseded in progressive establishments by the *rapid-transit elevated railway travelling crane*, occupying no floor space and limited in range only by the walls of the building in which it operates. While this modern economical and expeditious method of handling heavy merchandise may still be regarded as a novelty, it has passed the experimental stage, and the mechanism has already reached a degree of perfection which leaves little to be desired in respect of speed, safety, simplicity, and accuracy of operation. This is the result of much study, costly experiment, and practical experience.

The elevated railway travelling crane consists of four essential parts:—

(1.) The elevated tracks.
(2.) The travelling bridge.
(3.) The trolley car traversing the bridge and carrying the hoisting mechanism.
(4.) The motor or driving mechanism.

The Tracks.—Two independent elevated tracks, with, in some types, parallel tooth racks bolted thereto, are supported by iron columns (or, in the case of a new building specially constructed, built in and supported from the walls). These tracks run parallel to and close to the walls from one end of the building to the other. The bridge travels upon this runway propelled by positive gearing engaging with the racks, thus ensuring perfect alignment under all circumstances.

The Travelling Bridge.—The bridge is constructed of two parallel plate girders extending from rail to rail, spanning in mid-air the breadth of the building. Four large double-flanged steel-tyred wheels with steel axles running in bearings are bolted to projections on the girders, a skimming clearance only being permitted between the top of the rail and the bottom of the girders.

Between the girders heavy steel tracks are laid, bolted to their lower inner flanges, upon which a trolley car, carrying the hoisting mechanism, runs back and forth. Thus, by the two motions, the longitudinal motion of the bridge and the cross-motion of the trolley, every square foot of available space in the building can be covered.

The girders forming the sides of the bridge are securely tied together by angle-iron braces, and the bridge is still further stiffened against lateral strains by exterior girders, extending upwards and outwards at a sharp angle from the bottom flanges of the bridge members, and bolted to struts or braces extending across the top of the bridge. By this method of construction great rigidity is secured, while the entire space within and beneath the bridge is left unobstructed for the working of the trolley car and machinery.

(To be continued.)

Metal Trade Memoranda.

Messrs. Kirk Brothers, New Yard, Workington, have restarted several of their furnaces, after an idleness of several months' duration.

In the first four months of this year, 5000 tons of steel rails were exported from Belgium, about one-third of the quantity shipped in the corresponding period of 1892.

The German steel-plate makers have, with very few exceptions, been for some time regularly underbid by British firms for all important orders for steel ship plates. This state of things has caused some anxiety, and proposals have been made to alter the prices of steel plates.

The Momignies Iron Mines on the Franco-Belgian frontier have again been started. They date back from the days of the Romans, but for the last ten years have not been worked, owing to a dispute between the proprietors. The ore is a rich red hematite, and is very largely used locally.

Trade in Sheffield and the district has a more healthy appearance of late, the forges in some instances being better employed on machine and other sections, as well as on bars, sheets, brewery and other hoops. File makers find rather better employment, and there is an average output of wheels, grates, and ranges.

The Bengal Iron and Steel Company, Burrakur, have just completed a contract for the supply of 10,000 tons of pig iron to the East Indian Railway Company, and a new contract has been arranged for the supply of a similar quantity during the current year. At the works of the company there are now two furnaces in blast, producing 2500 tons of pig iron monthly.

All the American producers of copper, with a few not very important exceptions, are reported to have given their consent to the renewal of the agreement to restrict the output, which terminates at the end of the present month. Copper is already up to 30s. a ton from the lowest point. The statement that the yield from Chili has been much reduced is likely to have a firm effect on the market.

A statement has been issued showing the cost of making foundry pig iron by the Thomas Iron Company, Pennsylvania, from 1855 to 1892. It appears that in the year 1892 the average price of pig iron reached the lowest point in the United States—15⅝dols.—and since January 1 this year the price has averaged about 14·70dols. per ton. The highest average price in any year was in 1864, and the highest price in any month was in August, 1864, when it rose to 73·62dols. per ton. The lowest average for any year was 1892, and the lowest average for any month was March, 1893, when it was 14·69dols. per ton.

New Companies.

FERRY ENGINEERING COMPANY LIMITED.—This company was registered on the 16th inst., with a capital of £6000, in £10 shares, to adopt a certain agreement, and to carry on the business of engineers, contractors, bridge and pier builders, shipowners, builders, repairers, millwrights, etc. The first directors are M. Hill, H. Robertson, and J. Wallace; qualification, £50. Registered by P. J. Rutland, 69, Chancery-lane, W.C.

ATMOSPHERIC SILENT HOIST COMPANY LIMITED.—This company was registered on the 17th inst., with a capital of £6000, in £1 shares, to adopt an agreement and to acquire the patents, inventions, and improvements referred to therein, and to carry on the business of civil, marine, mechanical, and general engineers. Table A mainly applies. Registered by Paddison, Fullalove, Cummins and De la Chapelle, 14, Gray's Inn-square, W.C.

NORTH-EASTERN TELEPHONE COMPANY LIMITED.—This company was registered on the 20th inst., with a capital of £1000, in 500 preference and 500 ordinary shares of £1 each, to carry on the business of a telephone, electric light, heat and power-supply company, and in particular to establish, work, manage, control, and regulate telephone exchanges and works for the supply of electric light. The rules of Table A usually apply. Registered by Waterlow Brothers and Layton, 24 and 25, Birchin-lane, E.C.

ORME'S ELECTRIC SIGNAL SYNDICATE LIMITED.—This company was registered on the 15th inst., with a capital of £7500, in £1 shares, to acquire British patents, including one dated November 28, 1891, and numbered 20,742, and a provisional patent, dated February 17, 1893, granted to John Orme, in respect of an invention relating to electrical and automatic signalling; to adopt an arrangement made between J. Orme and — Andrews, and to carry on the business of the company. Table A applies with few exceptions. Registered by L. E. Brasseur and Oakley.

SALT LAKE AND OGDEN GAS AND ELECTRIC-LIGHT COMPANY LIMITED.—This company was registered on the 19th inst., with a capital of £300,000, in £1 shares, to carry on in the U.S.A., England, or elsewhere, and particularly in the territory of Utah, U.S.A., the business of a gas and electric-lighting company in all its branches, including the manufacture, sale, and supply of gas and electricity for lighting, heating, motive, and manufacturing purposes; electrical and heating engineers, and dealers in oils, minerals, and vegetables. The first

directors are to be appointed by the subscribers to the memorandum of association, and their number is not to exceed 250; remuneration, £600 per annum and percentage on profits, provided the amount so paid does not exceed £1200.

HASKIN WOOD VULCANISING COMPANY LIMITED.—This company was registered on the 15th inst., with a capital of £200,000, in £10 shares (8000 of which have been, or will be, allotted to S. E. Haskin, in his capacity of vendor), to purchase patents, etc., and in particular to acquire certain inventions in connection with the vulcanisation, seasoning, or preserving of wood, for which Mr. Haskin has already obtained the grant of letters patent, and to carry on the business of vulcanisers, seasoners, preservers, or manipulators of timber, timber and lumber merchants, sawmill proprietors, and many other kindred trades. There are not to be less than 3, nor more than 7, directors, and S. E. Haskin (the vendor) is to be the first; qualification, £500; remuneration, £200 per annum. Registered by J. and C. Robinson and Wilkins, 19, King's Arms-yard, E.C.

VALVELESS GAS ENGINE SYNDICATE LIMITED.—This company was registered on the 19th inst., with a capital of £15,000, in £10 shares, to purchase patents, etc.; to adopt an agreement made on the 14th inst. between J. Day and F. E. Wright for the acquirement of certain existing inventions and patents for gas and vapour engines; also another agreement made on the 14th inst. between Easton and Anderson Limited, J. Day, and F. E. Wright, being for granting a licence in respect of certain patent rights intended to be taken up by the syndicate, and to construct and maintain electric works, railway, and any other ways, water-courses, and warehouses. The first directors are E. M. Nelson and C. F. Cooper; qualification, £100; remuneration, £250 per annum. Registered by Faithfull and Owen, 11, Victoria-street, S.W.

Prize Competition.

WE OFFER FOUR GUINEAS MONTHLY IN PRIZES FOR THE BEST ORIGINAL ARTICLES SENT IN ON ANY MECHANICAL, ENGINEERING OR ELECTRICAL SUBJECT.

IN ORDER THAT MANAGERS, DRAUGHTSMEN, FOREMEN, AND WORKMEN WHO HAVE HAD NO PRACTICE IN WRITING MAY NOT HESITATE TO SEND IN COMPETITIONS, IT IS TO BE UNDERSTOOD THAT ALL ARTICLES WILL BE FULLY EDITED AND CORRECTED, AND JUDGED OF SOLELY ON THEIR MERITS AS ORIGINAL CONTRIBUTIONS FROM A PRACTICAL POINT OF VIEW. THE OBJECT OF THE COMPETITION IS TO INDUCE PRACTICAL MEN TO COME FORWARD AND GIVE THE RESULTS OF THEIR EXPERIENCE.

CONDITIONS.

Competitions for our Monthly Prizes must be sent so as to arrive at the Manchester Offices of THE MECHANICAL WORLD, New Bridge-street, not later than the last Tuesday in each month. Articles arriving after that time will be placed in the following month's competition.

Written competitions must be on one side of the paper only. The contributions must be original, and relate to matters connected with Engineering, Mechanism or Electricity.

The Proprietors of THE MECHANICAL WORLD reserve the right to publish any competition, whether it gains a prize or not.

The competitions may be accompanied by diagrams, sketches or drawings.

Competitors should write the words "Prize Competition" on the envelopes.

Competitors are not confined to one, but may send any number of competitions.

The correct name and address of the sender *must* be distinctly written upon every competition, not necessarily for publication. Competitions can appear under a *nom de plume.*

☞ We cannot undertake to be responsible for any MSS. sent to us, though when stamps are enclosed for the purpose we will endeavour to return rejected contributions.

The Metal Market.

PRICES CURRENT.

LONDON, June 26.

COPPER opened easy and 6s. 3d. lower at £44 7s. 6d. three months, and £44 6s. 3d. was soon accepted, cash passing at £44. The market further weakened to £43 17s. 6d and £43 15s. cash, and to £44 2s. 6d. and £44 1s. 3d. three months on free selling, induced, it is believed, by the disquieting financial reports from America. Prices rallied somewhat under good buying in the afternoon, three months making £44 2s. 6d. to £44 3s. 9d., and cash £43 16s. 3d., and the close was steady at a decline of 10s. to 11s. 3d. on the day. Sales, 1100 tons. Settlement price, £43 17s. 6d.

TIN was weak at the opening, the poor demand and the known flatness of the silver market, as well as sympathy with copper, affecting the price, which opened 25s. below Friday's official quotation, with cash at £87. The news of the substantial drop in silver received later in the day caused further weakness, cash passing at £88 15s. after the official close, making a drop of 30s. on the day for cash, and about 20s. for three months. Sales, 30 tons. Settlement price, £87. English ingots, £90 to £90 10s. Amsterdam market flat. Billiton, 53½; Banca, 55.

PIG IRON.—Business has been confined to Middlesbrough, of which 1500 tons changed hands at 35s. 8d. for two months and a week short. Scotch moved with Glasgow prices and closed 2½d. down, but Middlesbrough was 2d. up, and hematite about unchanged. Settlement prices:—Scotch, 41s. 9d.; Middlesbrough, 35s. 6d.; hematite, 45s.

TINPLATES are dull and unchanged.

LEAD has a steady market at £9 8s. 9d. sellers. English, £9 10s. to £9 11s. 3d.

SPELTER, for special brands, made £18, but the market closed quieter at £17 16s. 3d. to £17 17s. 6d. for ordinary.

ZINC SHEETS.—Silesian late last week was active and 2s. 6d. better at £20 12s. 6d., since when the price has been raised 5s. to £26 17s. 6d. ex ship. The V.M. brand is unaltered at £21 2s. 6d. f o.b. Antwerp, and £21 5s. ex-ship here.

OFFICIAL CLOSING QUOTATIONS.

	To-day.					
COPPER—	£	s.	d.	£	s.	d.
G. M. B.—Cash	43	17	6—	44	5	0
„ Three months	44	3	9—	44	11	3
TIN—						
Fine foreign—Cash	87	0	0—	87	10	0
„ „ Three months	84	15	0—	85	5	0
Australian—Cash	88	0	0—	88	10	0

PIG IRON—

	Scotch.				Middlesbrough.				Hematite.			
	Cash.		1 m'th.		Cash.		1 m'th.		Cash.		1 m'th.	
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
Close	41	9	41	11	35	6	35	8	45	0	45	2½
Prev. close	41	11½	42	1½	35	4	35	6	45	0	45	3

GLASGOW, June 26.—The pig-iron market was very quiet. Most of dealing in Scotch was on forfeit conditions, and there was none of outside buying, noticeable in early part of last week. Makers report that demand has for the moment slackened, as if consumers had supplied their wants. Scotch, which opened at 41s. 11d. cash, fell to 41s. 9½d., making a loss of 2½d. from Friday. Cleveland was firm, on the other hand, and 2d. higher. The Scotch shipments last week were 5993 tons, being a decrease of 512 tons on the corresponding week, and reducing the increase on the year to 1687 tons.

QUOTATIONS:—

	Scotch.				Middlesbrough.				Hematite.			
	Cash.		1 m'th.		Cash.		1 m'th.		Cash.		1 m'th.	
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
Highest	41	11	42	1½	35	6	35	7	45	0	45	3
Lowest	41	9½	41	11½	35	4½	35	7	45	0	45	3
Close	41	9	41	11	35	6	35	7	45	0	45	3
Prev. close	41	11½	42	1½	35	4	35	6	45	0	45	3

Official Gazette.

Partnership Dissolved.

J. A. BOND and F. R. BOND, malleable nail manufacturers, Birmingham, under the style of Richard Ashton and Co.

THE BANKRUPTCY ACTS, 1883 AND 1890.
Adjudication.

A. T. LINNETT and H. WHEELER (trading as A. T. Linnett and Co.), Birmingham, engineers and machinists.

Miscellaneous Items.

The Paris Tramway from St. Augustin to Vincennes, 10 kilometres, is being constructed with metallic sleepers, now for the first time used in Paris tramways.

The members of the Birmingham Association of Mechanical Engineers held their annual picnic on Saturday, the 17th inst., Lichfield being the place visited.

The Bristol Town Council have resolved to withdraw their bill now before Parliament, which sought powers to extend their docks at Avonmouth at a cost of £1,500,000.

The Manchester, Sheffield and Lincolnshire Company's steamer "Staveley" has accomplished the voyage between Grimsby and Hamburg in 25hrs. 5mins. The distance is 369 miles, the speed per hour averaging 14·15 miles.

A new petroleum conduit pipe is to be laid down alongside the railroad between Baku and Batoum at an estimated cost of nineteen millions of roubles. The oil will be hydraulically pumped from the Caspian end into the Batoum reservoirs.

The Legislative Council of Cyprus, at one of its recent sittings, passed a unanimous resolution in favour of the construction of a railway between Larnaca and Nicosia, the capital, *via* Pylia and the Messarian Plain. The line is to be 36 miles in length, and is estimated to cost £75,000.

At a meeting of the New Swindon Junior Engineering Society, held on the 21st inst., two papers were read, one by Mr. W. L. Holt and the other by Mr. H. G. Ashworth. The paper read by the former dealt with the works of Messrs. Stothert and Pitt Limited, and that of the latter with the Bath Electric Lighting Works.

The Government of India have approved of a project being drawn up by the agent of the Bengal North-Western Railway for the construction of a narrow-gauge line from Lucknow to the Ganges bridge at Cawnpore. This is the link required to the great metre gauge systems of Upper India and Rajputana.

The promoters of the new railway from Manchester to Glasgow are said to be well satisfied with the reception their project has obtained in the districts through which it is proposed the line shall run. The route is by way of Blakeley, Rhodes, Middleton, Heywood, Bamford, Rochdale, Bacup, Burnley, and then in almost a direct line to Newcastle, and forward to Glasgow.

The new bridge crossing the Kistna at Bezwada has just been completed, having occupied nearly three years in construction. It is designed to carry both the standard and the mètre-gauge systems, the object being to enable the Southern Mahratta narrow-gauge railway to have access to the important town of Bezwada, which is the centre of trade for the great and fertile delta of the Kistna. The bridge consists of twelve spans of 300ft. solid steel girders. Three of the girders had been got up by May, 1892, so that there remained nine to be erected during the current working of the season. Owing to the lateness of the floods it was not until early in December that a beginning could be made, and in the first week of February all were self-supporting. Such expedition could only have been made possible by the care and forethought with which, during the seven months of inaction, every detail had been worked out and designed. The work has also been done very cheaply, for the engineers expect to show a saving of over a lakh on the estimate for girder erection, and calculate that the rate per ton will work out at a lower figure than any yet touched for spans of the size. The well work was exceptionally heavy. The wells used had to be sunk to a depth of 80ft. beneath low water, or 50ft. below mean sea-level. From a width of one mile the river at the bridge site was narrowed to three-quarters of a mile by massive training embankments heavily pitched with stone.

Queries.

☞ Queries and Replies should arrive at the Manchester Office not later than by the first post on the Tuesday preceding the date of publication.

☞ Readers are invited to avail themselves of this section for practical information on questions relating to Mechanical Engineering and the Scientific Industries.

TURNING CHILLED ROLLS.—Can any reader oblige me with any information on this subject?—T. A.

WOOD'S AUTOMATIC PRESSURE RELIEF VALVE.—Required the address of the makers of this valve.—BELL AND CO.

WALTON WHEEL SCALE.—Required, information regarding the Walton Wheel Scale, or where it can be obtained.—A. L. J.

RAILWAY CROSSINGS.—Given the ratio of angle of intersection, say 1 in 8, what is the simplest method to convert into degrees of the quadrant?—L. V.

WIRE GAUZE.—Can any reader give a rule for the reduction of the effective area of a pipe by the interposition of a layer of wire gauze?—GAUZE.

CHURCHILL SLIDE VALVE.—Can any correspondent inform me who are the makers of the "Churchill Patent Slide Vale"? Any information would be thankfully received.—J. M.

RETEMPERING EDGE TOOLS.—Will any reader inform me if there is any method of tempering pattern makers' chisels and gouges that have been burnt in a pattern-shop?—CYMRO.

GUTTA - PERCHA.—Can anyone tell me of a process for melting either raw or manufactured gutta - percha, and how, after moulding, to cause the gutta to set firm and solid?—J. C. W

CLEANING BOILER TUBES.—Will some reader describe a useful tool to remove hard, thick scale from cross tubes in a vertical boiler? Tubes 9in. diameter and 4ft. 6in. long.—NOVICE.

WARSOP AERO STEAM ENGINE.—Any information about the working of the above engine, tried about 1870, such as the effect on the boiler, cylinder, piston rod, etc., will oblige—M. R.

GALVANISING.—Can any reader inform me whether it is possible to do galvanising on a small scale, say 3 or 4cwt. spelter bath; also the process of preparing cast-iron work for the bath?—T. J.

EMERY TAPE MACHINES.—I have an emery tape machine that I have a lot of trouble with through the tapes breaking continually. Can any reader who has a similar machine recommend a good tape?—CHEVIOT.

GAS ENGINE.—I have a gas engine with a separate compression cylinder by Storrie and Co., Glasgow. Can any reader inform me what the compression ought to be per square inch to obtain the best results?—J. PEARSON.

CASE-HARDENING FURNACE.—Will any practical reader give a sketch of a good furnace for case-hardening purposes, cutter-heating, etc., gas, liquid fuel, or coke, or the name of any maker of such?—LISTER AND CO., Keighley.

FLOWING WATER.—A river flows at the rate of, say, 20 miles an hour. If a tube perfectly smooth inside, of 2ft. diameter, were placed in the stream parallel to its surface, at what velocity would the water pass through the tube? Is there any rule for calculating this, and, if so, where can I find it?—SIGMA.

STAKING ON WHEELS, ETC.—Will any reader inform me of the best method of staking wheels or pulleys on shafts, say, with four or six keys? Should they be set true opposite the staking wedge, or opposite the permanent keys? Some information on this subject, or a sketch of same, would greatly oblige—STAKING WEDGE.

Replies.

☞ Owing to the constant increase in our correspondence, we regret that we have no alternative but to announce that we cannot reply by post to Queries even when stamped envelopes are sent.

☞ Queries and Replies must in all cases be accompanied by the names and addresses of the writers, as no notice will be taken of anonymous communications.

J. THOMPSON.—Apply to Mr. W. S. Worssam, Idol-lane, London, E.C.

PORTSMOUTH.—You will find full description and sketches in our issue for July 25, 1891.

J. PEARSON.—Are you quite sure the invention you refer to is precisely similar to that described?

LEON HARMEL (Val des Bois).—We will consider your suggestion at the commencement of a new volume.

P. M. FOWLER.—Your solution, which appears to meet the conditions imposed, arrived too late for consideration.

CONSTANT READER.—If you will refer to the working of the question referred to, you will notice that we have taken the square root of the sum instead of the product of the areas of the two ends. This will explain the discrepancy. Working in inches we have

$$11{,}309 + 4300 = 15{,}609, \text{ and } \sqrt{11{,}309 \times 4300} = 6973.$$

$$\text{Then } \frac{15609 + 6973}{3 \times 1728} = 436 \text{ cub. ft.}$$

E. H. S.—Seaton's "Manual of Marine Engineering," 18s., is the best book we know of. You might also obtain a copy of Reed's "Engineer's Handbook," 12s. 6d. Only the elements of algebra and geometry would be required.

L. E. W.—Bolting the weight to the brackets will practically not affect the calculation. If you refer to our issue for March 17, 1893, page 103, you will find the formula for the modulus of the section referred to (Fig. 12). The fact of the web being out of the centre does not affect the matter, as you will see by comparing the formula for Fig. 12 with that for Fig. 13. Note that if you use inches and pounds on one side of your equation, you must use the same units on the other side, and not tons, as you have done. If you can employ a continuous beam it would be preferable, but we should not reduce the section given by the formula.

OIL MERCHANTS.—Will any reader give me the London address of the Cleveland Lubricating Oil Company, U.S.A.?—A.H.——A.—The London address of the Cleveland Oil Company is at 18, Dockhead, London, S.E.—W. JONES.

FEED PUMPS.—In working out feed pumps for common high-pressure engines, Molesworth says, p. 493:—"Take cubic contents of cylinder and one steam passage and multiply by 4, and divide by proper specific volume for given pressure." Why multiply by 4? There are only two cylindersful of steam discharged to one revolution or one stroke of the pump. Then, again, should not the cubic contents of cylinder be taken to cut off only? For instance, if steam is cut off, say, at half-stroke, and initial pressure be 100lb., the specific volume for which is 270, we find a great difference from the plan of taking the full cylinder at the average pressure, which at 100lb. initial pressure will be 75 average, the specific volume for 75 being 353, not to mention the difference in the two cubic capacities. Feed pumps worked out according to Molesworth's rule and others always come out much too large—nearly three times. I shall be glad if some reader will explain this. — COLD WATER.——A.—The feed pump should supply from 2·5 to 3·5 times the quantity of water required. This accounts for it working out so large.—T. MANWARING.

Latest Inventions.

APPLICATIONS FOR LETTERS PATENT.

When Patents have been "communicated," the name of the communicating party is printed in italics.

Where complete specification accompanies application, an asterisk is suffixed.

10th June, 1893.

11,433 AUTOMATIC PUSH COCKS. W H Woods and W R Barter.

11,443 APPARATUS for FILTERING and PURIFYING or CLARIFYING WATER.* J Y Johnson. (*A Howatson, France.*)

11,445 MACHINES for FILING SAW-TEETH. J Storm.

11,452 PACKING CRAMPS for STEAM DEAL SAWING FRAMES. E Barnes.

11,453 BOATS. E H Girling and others.

11,454 MINERS' SAFETY LAMPS. W Ackroyd and W Best.

11,455 FIRE ESCAPES.* A Diss.

11,461 APPARATUS for COILING WIRE and WEAVING COILED WIRE FABRIC.* M B Lloyd and C O White.

12th June, 1893.

11,462 ELECTRICAL CONDUCTORS. J H Holmes and others.

11,469 VALVE GEAR of STEAM ENGINES. E E Baguley.

11,474 PINION LEVER. L Warner, jun., and L Warner, sen.

11,476 EQUILIBRIUM VALVES. W Reid.

11,480 OIL VAPOUR ENGINES. J Fielding.

11,481 LOAD GAUGE GLASS. G A Logsdail.

11,496 APPARATUS for REDUCING STEAM PRESSURE. J Whalley.

11,501 MEANS for RAISING WATER for PRODUCING MOTIVE POWER. C J Eyre.

11,506 LOCOMOTIVE TRAMWAY VEHICLES. C D Abel. (*C Lührig, Germany.*)

11,511 ROLLER GRINDING MILLS. C Hopkinson.

11,514 POWER HAMMERS.* J O'Brien.

11,516 ALTERNATE CURRENT DYNAMOS. J Y Johnson, (*La Société l'Eclairage Electrique, France.*)

11,517 DYNAMO ELECTRIC MACHINES. J Y Johnson (*La Société l'Eclairage Electrique, France.*)

11,518 APPARATUS for COUPLING and UNCOUPLING TRUCKS on RAILWAYS. W Bacon.

11,521 ELECTRIC MOTORS. P M Justice. (*The Clyde Electric Motor Company, United States.*)

11,524 APPARATUS for DRESSING TIN ORES.* J Rule.

11,526 SOLDER. J Biés-Albert.

11,529 REGULATING the BEARINGS of CONNECTING LINKS.* W and F Brockhausen.

11,531 MACHINE for STRAINING PULP. P Reinicke.

11,532 SIGNALLING SYSTEMS ADAPTED for RAILWAY USE.* P M Justice. (*J B Stewart and W G Watson, United States.*)

11,533 MACHINES for DRIVING SLUGS or NAILS.* J Y Johnson. (*S M Cutter, Canada.*)

13th June, 1893.

11,557 AUTOMATIC ELECTRIC CALL RECORDER. W J Chivers.

11,560 FURNACES for the MORE PERFECT CONSUMPTION of SMOKE. J Robson.

11,563 APPARATUS for HEATING AIR for STEAM BOILER FURNACES. J Hewden.

11,564 STEAM GENERATOR. G A Crane.

11,567 ELECTRIC LAMP, GAS, WATER, or MOTIVE FORCE METER. P Cadot and A Charron

11,570 ADJUSTABLE PACKING BLOCK and LIFTING JACK for SHORT DISTANCES. T F Clark.

11,577 STEAM MOTORS.* A J Boult. (*J Abel', Canada.*)

11,578 METHOD of ELECTRICALLY WELDING METALS.* W P Thompson. (*C L Coffin, United States.*)

11,579 APPARATUS for ELECTRICALLY HEATING or WELDING METAL.* W P Thompson. (*C L Coffin, United States.*)

11,580 APPARATUS for PUNCHING and HEATING METAL.* W P Thompson. (*C L Coffin, United States.*)

11,581 PRODUCTION and SEPARATION of SULPHIDE of NICKEL from ORES of NICKEL and COPPER. W P Thompson. (*C C Bartlett, United States.*)

11,582 DRIVING PARTS, SLIDE WAYS, AXLE BOXES, and the LIKE. R Claessen and M Willenius.

11,583 ROLLER BEARINGS for SHEAVES of PULLEY BLOCKS, CASTOR WHEELS, ETC. W P Thompson. (*J S W Thompson, United States.*)

11,584 PNEUMATIC SHEET or PAPER-FEEDING MECHANISM for PRINTING MACHINERY.* J P Luhn.

11,591 GALVANISING METAL. E and A Smith.

11,592 ANNEALING and HARDENING STEEL WIRE. E and A Smith.

11,598 CAR COUPLING. S Shepardson.

11,600 HYDRAULIC and SCREW - PRESSING MACHINE, with WEIGHING MACHINE ATTACHED. J Bamber.

11,601 AUTOMATIC UNIFORM SPEED REGULATOR for GOVERNORS.* F S Naylor.

11,602 WRENCHES for PIPES and BARS. E G Brewer. (*I H Williams and W Cox, Redfield, United States.*)

11,603 MEANS for OPERATING RAILWAY-CROSSING and OTHER GATES. J T Crim.

11,605 STATION INDICATOR for RAILWAY CARRIAGES, ETC. T Bastin.

11,606 METHOD of STRAINING and SECURING WIRE or CORD. E C Hawtrey.

11,607 VALVES for PERCUSSIVE ROCK DRILLS, DIRECT-ACTING PUMPS, and ENGINES. A W and Z W Daw.

11,608 ELECTRICAL HEATERS.* J F McElroy.

11,609 ELECTRIC SWITCHES.* J F McElroy.

11,610 APPARATUS EMPLOYED in the EVOLUTION and COLLECTION of HYDROGEN and OXYGEN GASES by ELECTROLYSIS. C J Yarnold.

11,611 SCREW-DRIVERS. A Mallock.

11,619 LOCOMOTIVE ENGINES. J J Harrison.

11,622 PROCESS of MAGNETIC SEPARATION and APPARATUS ADAPTED to the CONDUCT of SUCH PROCESS.* R H Sanders and C T Thompson.

11,623 APPARATUS for CULTIVATING or BREAKING-UP RIDGES and FURROWS. A and A Bourdin.

11,624 CONVEYORS.* J M Dodge.

11,625 CONVEYORS.* J M Dodge.

11,626 CONVEYORS.* J M Dodge.

11,627 APPARATUS for ASCERTAINING ALTITUDES. G C Lilley.

11,628 MEANS for RAISING SUNKEN SHIPS. E Wall.

11,629 HYDRAULIC ELEVATORS.* S A Worcester.

11,632 DRAUGHT APPLIANCES for SMOKE STACKS.* J C Chapman. (*Taylor's Improved Draught Company, United States.*)

11,643 DIFFERENTIAL HOISTING TACKLE. W Schermuly.

11,645 EXPLOSIVE COMPOUNDS. A V Newton. (*A Nobel, France.*)

11,646 THILL COUPLINGS. A M Clark. (*A Engelhard, United States.*)

11,649 APPARATUS for FACILITATING TELEPHONIC INTERCOMMUNICATION. Sir C S Forbes., Bart

11,651 DOMESTIC GAS-HEATED BOILERS. W D Wansbrough.

11,652 APPARATUS CONNECTED with the RECOVERY of GOLD and SILVER, PRECIPITATED from SOLUTIONS by METALS. J Loevy.

11,647 WATER WHEELS. A B Frame.

14th June, 1893.

11,658 MACHINERY for FORMING LOCK NUTS. J R Peacock and J Wilkinson.

11,659 IRON and STEEL TUBES. F W Ratcliff and P E Griffiths.

11,670 APPLIANCE for MAKING LOAM CORES. F A Williams.

11,674 ARRANGEMENTS of BOILER FLUES for the MORE ECONOMICAL WORKING of STEAM BOILERS and MORE EQUAL DISTRIBUTION of HEAT. G Padget.

11,675 LEVELLING, ANGLE, and GRADIENT-MEASURING INSTRUMENT for SURVEYING PURPOSES. J W Shepard.

11,676 SELF-ACTING POWER TRANSMITTER and CONTINUOUS BRAKE OPERATOR for ENGINES, CARS, ETC. J Smith.

11,682 DRAWING COMPASSES. J Norris.

11,685 MACHINE for PRESSING BALES. M H Crummie.

11,689 MARINE NIGHT-SIGNALLING APPARATUS. A Taylor.

11,690 SMOKE CONSUMER. J Robinson.

11,691 SMOKE-CONSUMING APPLIANCE for STEAM GENERATOR FURNACES. H H Cribb and H J Hooke.

11,703 METHOD of PREPARING METAL SHEETS for the PURPOSE of GALVANISING THEM or COATING THEM WITH METAL or METALLIC ALLOY. Davies Brothers and Co. Limited and E A Davies.

11,704 INDEPENDENT ACTION BALL and VALVE. T E Phillips.

11,707 METHOD of TRANSMITTING POWER. M R Ward.

11,709 PURIFICATION of IRON for CASTING and GENERAL FOUNDRY PURPOSES. J B Cochrane and T H Taylor.

11,710 TUBULAR STEAM BOILERS. E Petersen.

11,713 ROTARY ENGINES.* G H Graham.

11,715 PORTABLE STEAM FIRE ENGINES. J C Merryweather and C J W Jakeman.

11,716 The "PREVENTUM" CRANK and WIRE and ELECTRIC PULL-OUT BELL-PULL. C Parkes.

11,718 APPARATUS for REPLACING DERAILED RAILWAY CARS. J Fisher and others.

11,719 NUT LOCK. E Poirier.

11,725 PROCESS of REPLACING by AIR the STEAM CONTAINED in the INTERSTICES AFTER TREATMENT in a STEAM DISINFECTING or COOKING APPARATUS.* A B Reck.

11,728 SWITCHES for ELECTRIC CURRENTS. E F Moy.

11,729 COIN-FREED MACHINES for ADMINISTERING ELECTRIC CURRENTS.* P Reiner.

11,732 STEAM GENERATOR FURNACES. C C Black.

11,734 GAS CONDENSERS. S Cutler.

11,737 ROTARY PUMPS. E Towlson and the Rotary Engine Syndicate Limited.

11,741 CRANKLESS DUPLEX COMPOUND PUMPING ENGINE. J J Holmes.

11,744 JOURNAL LUBRICATORS.* W W Smith.

11,745 PAPER MACHINES.* L Schopper.

11,749 HEATING LIQUIDS by ELECTRICITY. A B Woakes.

11,751 DIFFERENTIAL SPECIFIC GRAVITY MOTORS. L Gunn and M G E Cuddon.

15th June, 1893.

11,757 APPLIANCE for the INTERLOCKING of GATES WITH SIGNALS at LEVEL CROSSINGS. W H Elliott.

11,759 ELECTRIC BELLS. C Turnbull, jun.

11,762 GAS or OIL ENGINES. J H Hamilton.

11,764 STARTING, REGULATING, and STOPPING MECHANISM for PAINTING MACHINERY. W H Blakeney.

11,771 CHAIN CONVEYORS.* M H Larmuth.

11,774 SMELTING IRON and IRON ORES. A C Wilson and H Tomkins.

11,778 AUTOMATIC COMPRESSED AIR INJECTOR, for IMPROVEMENT in CONDENSING ENGINES. J W and C Kiddle.

11,779 SCREW PROPELLERS. F F Fisher.

11,783 PROPELLING APPARATUS for SHIPS. T Armstrong.

11,786 FURNACES. L A Edwards and F G Wright.

11,791 PROPELLER SHAFTS. H G Dunstan and T Wescombe.

11,792 LINING of KILNS and FURNACES. H Faija.

11,801 APPLIANCES CONNECTED WITH SECURING ELECTRIC-LIGHT FITTINGS. C N Russell.

11,814 COMBINATION TOOL. T G Parkinson and others.

11,819 ELECTRIC RAILWAY TROLLEYS.* E H Allen.

11,821 HOISTING APPARATUS APPLICABLE for PILE DRIVERS, LIFTS, ETC. G B Shepherd.

11,825 CAR COUPLING. P R J Willis. (*S D Sams and L D Sweet, United States.*)

11,827 APPARATUS for ASCERTAINING the POSITION of TRAINS on RAILWAYS. P R J Willis. (*R D Peters, United States.*)

16th June, 1893.

11,831 RUDDER for SAILING or STEAM VESSELS. J Bishop.

11,837 FUEL for GAS FIRES. W T Crooke and T Cartwright.

11,839 APPARATUS to FACILITATE MODEL DRAWING or the TEACHING of MODEL DRAWING. W Bartle.

11,842 INSULATION of ELECTRICAL CONDUCTORS. E Payne.

11,863 PREPARED FUEL. E W Harding.

11,868 LEAD and SIMILAR PIPES.* G W Fox.

11,878 WOOD and OTHER SCREWS, and SCREW DRIVERS for the SAME. M H Lowe. (*A T Danks, Australia.*)

11,879 INSTRUMENT for USE in MAKING PERSPECTIVE and OTHER DRAWINGS. L Dietmann.

11,881 STREET ROLLERS.* B J B Mills. (*R C Pope, United States.*)

11,890 TELEPHONES. P Rabbidge.

17th June, 1893.

11,917 HAULING or TRANSMITTING GEAR for UNDERGROUND and OTHER PURPOSES. J S Walker and others.

11,921 SUSPENSORY APPARATUS DESIGNED for ELECTRIC and OTHER HANGING LAMPS. W H Johnson.

11,923 ARGAND or CIRCULAR-FLAME GAS BURNERS. C H Harrison.

11,940 THRUST BLOCK BEARINGS. W Hamilton.

11,942 VESSELS for CONTAINING COMPRESSED or RAREFIED AIR or GAS. S Alley and J A Maclellan.

11,943 PULP STRAINERS of PAPER-MAKING MACHINES. D N Bertram.

11,955 APPARATUS for HARDENING and TEMPERING in CONTINUOUS or OTHER LENGTHS STEEL WIRE BRIGHT. E Oddy and others.

11,960 PEDAL PUMP WITH CONTINUOUS ACTION. S S Bromhead. (*L A Ferron, France.*)

11,956 PAPER PULP REFINING ENGINE.* D Pearson and D N Bertram.

11,962 FOG-SIGNALLING APPARATUS for USE on RAILWAYS. R Parsons.

11,970 RAILWAY WAGON COUPLINGS. J W Brook.

11,977 ELECTRICAL SEARCH and SIGNALLING-LIGHT APPARATUS. S O Cowper-Coles.

11,980 COUNTING and SEPARATING MACHINES for GOLD, SILVER, and COPPER. G W Mackay.

11,983 CONTACT PLATES or ELECTRODES for FORMING and CHARGING, or for ALTERNATELY CHARGING and DISCHARGING, PLATES or ELEMENTS to be USED in VOLTAIC BATTERIES. D G Fitzgerald.

11,984 VALVES and METALLIC PACKING in SINGLE-ACTING ENGINES. M H Robinson and others.

11,987 FOGHORN or MARINE SIGNALLING DEVICE.* J Speirs.

11,992 FRICTION CLUTCHES or TRANSMITTERS. P Mahony and A G Palmer.

Manuscript Specifications of Patents can be examined at the Patent Office, London, after the Complete Specification has been accepted, on payment of 1s. The printed Specifications are usually published in about one month after acceptance of the Complete Specification, and any single copy may be obtained by remitting 8d. in stamps (or by special post cards sold at the Post Offices at 8d. each) to SIR H. READER LACK, *Comptroller General, Patent Office, 25, Southampton Buildings, Chancery-lane, London. When a number of Specifications are required, remittances may be made by P.O.O*

ENGINEERS AND METAL TRADES' DIRECTORY:

BEING AN INDEX TO THE ADVERTISEMENTS IN THIS JOURNAL.

. Where the numeral is absent, the Advertisement does not appear this week.